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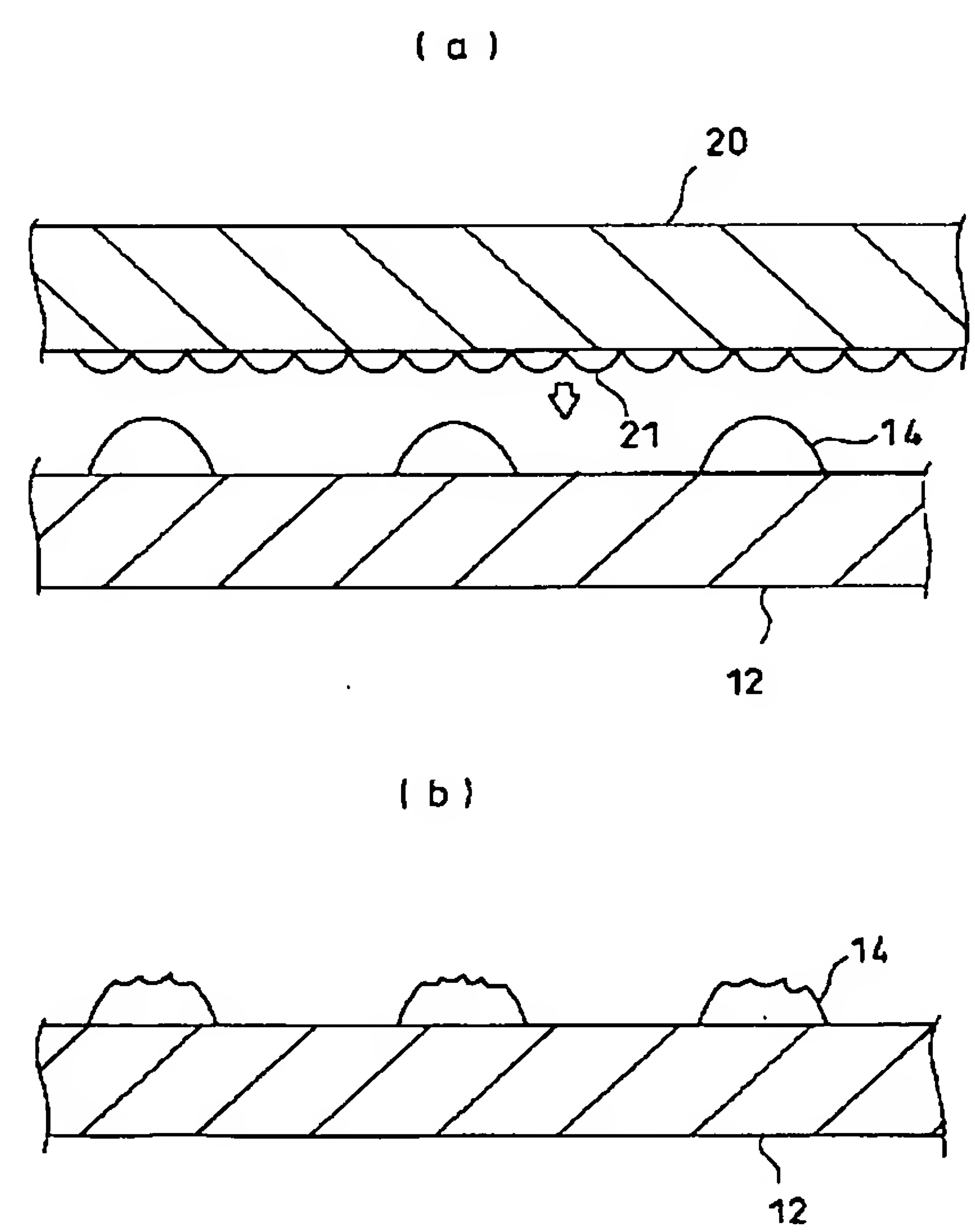
(54)【発明の名称】　プローブカードの製造方法

(57)【要約】

【目的】　バンプの先端面に均一な凹凸を形成することにより、半導体チップの検査用電極の表面酸化膜が確実に破れるようにする。

【構成】　フレキシブル基板の表面に半導体チップの検査用電極と接続されるバンプを形成する。平坦な金属板２０に、フレキシブル基板１２のバンプ１４よりも硬い材料よりなりバンプ１４の径の半分以下の径の凸部又は凹部を有するメッキ層２１を形成する。バンプ１４の先端面に金属板２０のメッキ層２１を押しつけることにより、バンプ１４の先端面に凹凸部を形成する。



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【特許請求の範囲】

【請求項１】　半導体ウェハ上に形成された半導体チップの電気特性を検査するためのプローブカードの製造方法であって、
配線基板の表面に、前記半導体チップの検査用電極と接続されるバンプを形成する工程と、
押圧用基板に、前記バンプよりも硬い材料よりなり前記バンプの径の半分以下の径の凸部又は凹部を有する表面層を形成する工程と、
前記バンプの先端面に前記押圧用基板の表面層を押しつけることにより、前記バンプの先端面に凹凸部を形成する工程とを備えていることを特徴とするプローブカードの製造方法。

【請求項２】　前記押圧用基板に前記表面層を形成する工程は、前記押圧用基板の表面にメッキ法によりＮｉ、Ｒｈ、Ｐｄ若しくはＷよりなる金属粒子又はセラミックス若しくはＳｉO_2よりなる粒子を形成する工程を含むことを特徴とする請求項１に記載のプローブカードの製造方法。

【請求項３】　前記押圧用基板に前記表面層を形成する工程は、前記押圧用基板の表面に接着剤によりＮｉ、Ｒｈ、Ｐｄ又はＷよりなる粒子を固定する工程を含むことを特徴とする請求項１に記載のプローブカードの製造方法。

【請求項４】　先端面に凹凸部が形成された前記バンプの表面に、該バンプよりも硬い金属よりなるメッキ層を形成する工程を備えていることを特徴とする請求項１～３のいずれか１項に記載のプローブカードの製造方法。

【請求項５】　前記バンプの先端面に前記押圧用基板の表面層を押し付ける工程において、押し付け回数は２回以上であり、１回押し付ける毎に前記バンプに接触する前記押圧用基板の位置を変えることを特徴とする請求項１～４のいずれか１項に記載のプローブカードの製造方法。

【請求項６】　半導体ウェハ上に形成された半導体チップの電気特性を検査するためのプローブカードの製造方法であって、
下層の金属配線と上層の金属電極との間又は基材と前記金属電極との間に層間絶縁膜を有する配線基板と、前記上層の金属電極と電気的に接続するように形成され前記半導体チップの検査用電極と接続されるバンプとを、前記層間絶縁膜が軟化する温度で保持した状態で、前記バンプの先端を平坦な基板に押し付けて前記バンプの先端を同一平面上に位置させる工程を備えていることを特徴とするプローブカードの製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、半導体ウェハ上に形成された複数の半導体チップの集積回路をウェハ状態で一括して検査するためのプローブカードの製造方法に関する。

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【０００２】

【従来の技術】近年、半導体集積回路装置（以後、半導体装置を称する。）を搭載した電子機器の小型化及び低価格化の進歩は目ざましく、これに伴って、半導体装置に対する小型化及び低価格化の要求が強くなっている。

【０００３】通常、半導体装置は、半導体チップとリードフレームとがボンディングワイヤによって電気的に接続された後、半導体チップ及びリードフレームが樹脂又はセラミクスにより封止された状態で供給され、プリント基板に実装される。ところが、電子機器の小型化の要求から、半導体装置を半導体ウエハから切り出したままの状態（以後、この状態の半導体装置をベアチップと称する。）で回路基板に直接実装する方法が開発され、品質が保証されたベアチップを低価格で供給することが望まれている。

【０００４】ベアチップに対して品質保証を行なうためには、半導体装置に対してウェハ状態でバーンイン等の検査をする必要がある。ところが、半導体ウェハ上に形成されている複数のベアチップに対して１個又は数個づつ何度にも分けて検査を行なうことは多くの時間を要するので、時間的にもコスト的にも現実的ではない。そこで、全てのベアチップに対してウェハ状態で一括してバーンイン等の検査を行なうことが要求される。

【０００５】ベアチップに対してウェハ状態で一括して検査を行なうには、半導体ウェハ上に形成された複数の半導体チップの検査用電極に電源電圧や信号を同時に印加し、該複数の半導体チップを動作させる必要がある。このためには、非常に多く（通常、数千個以上）のプローブ針を持つプローブカードを用意する必要があるが、このようにするには、従来のニードル型プローブカードではピン数の点からも価格の点からも対応できない。

【０００６】そこで、フレキシブル配線基板上に、半導体チップの検査用電極と接続されるバンプが設けられた薄膜型のプローブカードよりなるコンタクタが提案されている（日東技報 Vol.28,No.2(Oct. 1990 PP.57-62 を参照）。

【０００７】以下、前記のプローブカードの製造方法及び該プローブカードを用いて行なう半導体装置の検査方法について説明する。

【０００８】まず、金属箔の表面に絶縁層を形成した後、該絶縁層にスルーホールを形成した後、金属箔にメッキ用電極の一方を接続して電気メッキを行なう。メッキ層は、スルーホールを埋めるように進んだ後、絶縁層の表面まで達すると、該表面に等方的に拡がって半球状になる。該半球状のメッキ層が検査用のバンプである。その後、金属箔に対してエッチングを行ない回路パターンを形成してプローブカードを製造する。

【０００９】次に、プローブカードと半導体ウェハとのアライメントを行なった後、プローブカードを半導体ウ

ェハに押し付けて、プローブカードのバンプを半導体チップの検査用電極に接触させ、その後、バンプに電源電圧や信号電圧を印加して半導体装置の検査を行なう。

【００１０】ところで、半導体チップの検査用電極は、通常アルミニウム等の酸化し易い金属により形成されているため、検査用電極の表面はアルミナ等の表面酸化膜によって覆われている。そこで、プローブカードのバンプと半導体チップの検査用電極との良好な電気的接続を得るために、プローブカードを半導体ウェハに対して押圧し、該押圧力によって表面酸化膜を破る必要がある。

【００１１】

【発明が解決しようとする課題】ところが、半導体ウェハに形成される半導体チップの数が多くなってくると、プローブカードに形成されるバンプの数が増加し、バンプ１個当たりに加えられる押圧力は減少せざるを得ない。このため、表面酸化膜をバンプによって確実に破ることができなくなり、バンプと検査用電極との間の接触抵抗にバラツキが生じるという問題がある。

【００１２】そこで、本件発明者らは、バンプと検査用電極との接触面積を小さくすることにより、バンプ１個当たりに加えられる押圧力が一定でも単位接触面積当たりの荷重が大きくなり、これにより、検査用電極の表面酸化膜が確実に破れるようにすることを考慮した。

【００１３】具体的には、単位接触面積当たりの荷重を大きくするための方策として、バンプの表面にメッキ法により凹凸を形成する方法、バンプの表面にエッチングを行なって凹凸を形成する方法、バンプの表面に微細な粒子を埋め込んで凹凸を形成する方法等を考慮した。

【００１４】ところが、いずれの方法によっても、低コストにバンプの先端面に均一な凹凸を形成することができないという第１の問題がある。

【００１５】また、半導体ウェハが極めて平坦であるのに対して、プローブカードの平坦性は十分でないため、バンプの先端は同一の平面上に位置しないことが多い。このため、半導体ウェハの直径が大きくなり半導体チップの数が多くなると、プローブカードのすべてのバンプと半導体チップのすべての検査用電極とが確実に接続されないという第２の問題がある。

【００１６】前記に鑑み、本発明は、低コストにバンプの先端面に均一な凹凸を形成することができ、これにより、半導体チップの検査用電極の表面酸化膜が確実に破れるようにすることを第１の目的とし、プローブカードのすべてのバンプの先端を同一の平面上に位置させ、これにより、プローブカードのすべてのバンプと半導体チップのすべての検査用電極とが確実に接続されるようにすることを第２の目的とする。

【００１７】

【課題を解決するための手段】前記の第１の目的を達成するため、請求項１の発明は、バンプよりも硬い材料よりなる凹凸部を有する基板にバンプの先端面を押し付けることにより、バンプの先端面に凹凸を形成するものである。

【００１８】具体的に請求項１の発明が講じた解決手段は、半導体ウェハ上に形成された半導体チップの電気特性を検査するためのプローブカードの製造方法を対象とし、配線基板の表面に、前記半導体チップの検査用電極と接続されるバンプを形成する工程と、押圧用基板に、前記バンプよりも硬い材料よりなり前記バンプの径の半分以下の径の凸部又は凹部を有する表面層を形成する工程と、前記バンプの先端面に前記押圧用基板の表面層を押しつけることにより、前記バンプの先端面に凹凸部を形成する工程とを備えている構成とするものである。

【００１９】請求項２の発明は、請求項１の構成に、前記押圧用基板に前記表面層を形成する工程は、前記押圧用基板の表面にメッキ法によりＮｉ、Ｒｈ、Ｐｄ若しくはＷよりなる金属粒子又はセラミックス若しくはSiO_2 よりなる粒子を形成する工程を含む構成を付加するものである。

【００２０】請求項３の発明は、請求項１の構成に、前記押圧用基板に前記表面層を形成する工程は、前記押圧用基板の表面に接着剤によりＮｉ、Ｒｈ、Ｐｄ又はＷよりなる粒子を固定する工程を含む構成を付加するものである。

【００２１】請求項４の発明は、請求項１～３の構成に、先端面に凹凸部が形成された前記バンプの表面に、該バンプよりも硬い金属よりなるメッキ層を形成する工程を備えている構成を付加するものである。

【００２２】請求項５の発明は、請求項１～４の構成に、前記バンプの先端面に前記押圧用基板の表面層を押し付ける工程において、押し付け回数は２回以上であり、１回押し付ける毎に前記バンプに接触する前記押圧用基板の位置を変える構成を付加するものである。

【００２３】前記の第２の目的を達成するため、請求項６の発明は、バンプの先端が同一平面上に位置するように層間絶縁膜を塑性変形させるものである。

【００２４】具体的に請求項６の発明が講じた解決手段は、半導体ウェハ上に形成された半導体チップの電気特性を検査するためのプローブカードの製造方法を対象とし、下層の金属配線と上層の金属電極との間又は基材と金属電極との間に層間絶縁膜を有する配線基板と、前記上層の金属電極と電気的に接続するように形成され前記半導体チップの検査用電極と接続されるバンプとを、前記層間絶縁膜が軟化する温度で保持した状態で、前記バンプの先端を平坦な基板に押し付けて前記バンプの先端を同一平面上に位置させる工程を備えている構成とするものである。

【００２５】

【作用】請求項１の構成により、バンプよりも硬い材料よりなりバンプの径の半分以下の径の凸部又は凹部を有する表面層をバンプの先端面に押しつけると、バンプの

先端面には前記表面層の凸部又は凹部が転写されるので凹凸部が形成される。

【００２６】請求項２の構成により、押圧用基板の表面にメッキ法によりＮｉ、Ｒｈ、Ｐｄ若しくはＷよりなる金属粒子又はセラミックス若しくはSiO_2よりなる粒子を形成するため、均一で且つ所望の大きさの径を有する凹凸部を押圧用基板の表面に形成することができる。

【００２７】請求項３の構成により、押圧用基板の表面に接着剤によりＮｉ、Ｒｈ、Ｐｄ又はＷよりなる粒子を固定するため、均一で且つ所望の大きさの径を有する凹凸部を押圧用基板の表面に形成することができる。

【００２８】請求項４の構成により、先端面に凹凸部が形成されたバンプの表面にバンプよりも硬い金属よりなるメッキ層を形成するため、バンプ先端面の凹凸部は摩耗し難くなる。

【００２９】請求項５の構成により、バンプの先端に押圧用基板の表面を位置をずらしながら２回以上押し付けるため、均一で且つ所望の大きさの径を有する凹凸部をバンプの先端に形成することができる。

【００３０】請求項６の構成により、バンプが形成された配線基板を層間絶縁膜が軟化する温度で保持した状態で、バンプの先端を平坦な基板に押し付けると、バンプの先端が同一平面上に位置するように層間絶縁膜は変形する。その後、フレキシブル基板の温度を常温に戻すと、層間絶縁膜はバンプの先端が同一平面上に位置する状態を保持して硬化する。この場合、層間絶縁膜が軟化する温度はバーンインの温度よりも高いので、塑性変形した層間絶縁膜がバーンイン時に再度変形することがないので、良好にバーンインを行なうことができる。

【００３１】

【実施例】以下、図１及び図２を参照しながら本発明の一実施例に係るプローブカードの製造方法について説明する。

【００３２】まず、フレキシブル配線基板の表面に、半導体チップの検査用電極と接続されるバンプを形成する。

【００３３】図１（ａ）に示すように、厚さ約１８μｍの銅箔１０の一面にポリイミド（又はポリイミド前駆体）をキャスティングした後、ポリイミドを加熱して乾燥及び硬化させてポリイミド層１１を形成する。硬化後のポリイミド層１１の厚さは約２５μｍである。ポリイミドの熱膨張率は銅の熱膨張率（16×10^{-6}／℃）と略同じであるので、銅箔１０及びポリイミド層１１よりなるフレキシブル基板１２の熱履歴による反りは少ない。

【００３４】その後、図１（ｂ）に示すように、ポリイミド層１１に直径約３０μｍのスルーホール１３を形成する。その後、銅箔１０の他面にレジスト（図示は省略している。）を塗布した後、銅箔１０にメッキ用電極の一方を接続してＮｉの電気メッキを行なう。銅箔１０の他面はレジストに覆われているためＮｉはメッキされない。メッキ層はスルーホール１３を埋めるように形成された後、ポリイミド層１１の表面に達すると、等方的に拡がって半球状になり、直径約４５μｍのバンプ１４が形成される。

【００３５】その後、銅箔１０の他面に塗布されたレジストを除去した後、図１（ｃ）に示すように、周知の方法により銅箔１０に対してエッチングを行なって回路パターン１５を形成する。

【００３６】ここで、配線基板としては、前記フレキシブル配線基板のほかに、その基材として、シリコン、ガラス、セラミックス又はガラスエポキシ等を用いた配線基板（以後、ハード基板と称する）を使用してもよい。

【００３７】次に、押圧用基板に凸部又は凹部を有する表面部を形成する。

【００３８】例えば銅よりなる金属板の表面に電気メッキを施して、例えばＮｉよりなり粒径が１～１０μｍ程度のメッキ層を表面層として形成する。このメッキ層におけるＮｉ粒子の粒径については、メッキ液の添加剤及び電流密度を変化させることにより制御可能である。すなわち、通常、メッキにより生成させるＮｉの粒径を小さくするため、例えばサッカリンのような添加剤が用いられるが、その添加量を少なくするとＮｉの粒径が小さくなる。また、電流密度を低くすると粒径が小さくなり、電流密度を高くすると粒径が大きくなる。従って、メッキ液の添加剤及び電流密度を変化させることにより１～１０μｍ程度の粒径の粒子よりなるメッキ層を形成することができる。

【００３９】図２はＮｉメッキの粒子の分布状態を示す拡大写真を示しており、粒径が約５～１０μｍの場合であって、粒子の分布が密で且つ均一になっている。

【００４０】尚、押圧用基板に凸部又は凹部を有する表面層の形成方法については、電気メッキ法の代わりに、板ガラスよりなる押圧用基板の表面を砂で擦って粒径が１～１０μｍ程度の凹凸部を形成してもよいし、押圧用基板の表面に粒径が１～１０μｍの粒子を均一に付着させてもよい。

【００４１】次に、バンプ１４の先端面に押圧用基板の表面層を押し当てて、バンプ１４の先端面に凹凸部を形成する。

【００４２】図３（ａ）に示すように、フレキシブル基板１２のバンプ１４に対して、金属板２０の表面に形成された３～１０μｍの粒径のメッキ層２１を押し付けることにより、図３（ｂ）に示すように、バンプ１４の先端面に凹凸部を形成する。

【００４３】このときの加圧力は、直径４０μｍのＡｕバンプの場合、１バンプ当たり５～５０ｇで、できれば１５～２５ｇが好ましい。また、押し付け回数は、１回でもほぼ目的の凹凸部を形成することができるが、２～３回繰り返し押し付けることにより、より均一さを満た

すことができる。複数回押し付ける場合には、１度押し付ける毎に金属板２０の位置をずらし、バンプ１４が金属板２０の表面に形成されたメッキ層２１の同一箇所に当たらないようにすると良い。

【００４４】次に、バンプ１４の先端面にメッキ層よりなる表面保護膜を形成する。

【００４５】メッキの種類としては電解メッキ又は無電解メッキのいずれでもよく、メッキ層を構成する金属材料としてはＮｉよりも硬いＲｈ、Ｎｉ、Ｐｄ、W等が挙げられ、メッキ層の厚さとしてはバンプ１４の先端面に形成された凹凸部が隠れてしまわないように１μm以下が好ましい。

【００４６】次に、シリコン、ガラス、セラミックス、ガラスエポキシ等を基材に用いたハード基板及びバンプよりなるプローブカードの製造方法について説明する。

【００４７】ハード基板は、その平坦性が十分ではないため、レベリング（平坦化）を行なってから使用する。通常、ハード基板の平坦度は、その基材や製法により異なるが、基板の大きさに対して０．０１～１％程度であって、１５０mm×１５０mmの基板では数１０μm以上の凹凸がある。また、バンプ高さのバラツキは、その形成方法により異なるが、１５０mm×１５０mmのエリアでは１～５μm程度である。半導体ウェハが極めて平坦であるのに対して、プローブカードが平坦とは言えないため、プローブカードのすべてのバンプと半導体チップの検査用電極とが同時に確実に接続しないことがある。そこで、両者を同時に確実に接続させるために、プローブカードに対してレベリングを行なうものである。

【００４８】以下、図９を参照しながら、レベリングの方法について説明する。

【００４９】まず、ガラス基板４１上に、金属配線４２と、さらに層間絶縁膜４３を介して金属電極４４を形成する。層間絶縁膜４３には、エポキシ樹脂、ポリイミド樹脂等を用いる。

【００５０】次に、感光性レジスト等を使用して金属電極４４の上にバンプ４５を形成する。このバンプ４５の先端は、同一の平面上に位置せず、数１０μmから数１００μmのバラツキを生じる。この主要因として、ガラス基板４１の平坦度、層間絶縁膜４３の厚さのバラツキ及びバンプ４５の高さのバラツキ等がある。

【００５１】ハード基板及びバンプよりなるプローブカードを平坦な一対の基板により挟んだ状態で例えば１８０℃程度に加熱する。このようにすると、プローブカードにおける下層の金属配線と上層の金属電極との間又は基材と金属電極との間の層間絶縁膜が軟化して、バンプの先端の位置は同一平面上に位置するようになる。その後、プローブカードを常温まで冷却しても、層間絶縁膜が塑性変形しているので、バンプの先端の位置は同一平面上に位置したままである。

【００５２】以下、本発明を評価するために行なった評価テストについて説明する。

【００５３】図４は、アルミニウム電極３０の表面に形成されたアルミナ層３１に、先端面に凹凸部を有するバンプ１４を押し付ける方法を示している。この場合の押し付け荷重は、バンプ１個当たり１０ｇ程度である。

【００５４】図５は、従来の半球状のバンプをアルミニウム電極に押し付けたときにアルミナ層に形成された圧痕を示しており、アルミニウム電極には整った形状の窪みが形成されており、アルミナ層は十分に破れてはいない。

【００５５】図６～図７は、前記実施例により製造したバンプをアルミニウム電極に押し付けたときにアルミナ層に形成された圧痕を示しており、Ｎｏ．１～Ｎｏ．６のいずれのサンプルにおいても、アルミニウム電極には複雑な形状の窪みが形成されており、アルミナ層は確実に破れている。

【００５６】図８は、従来の半球状の直径４０μmのバンプ（図中においては半球状バンプと記載している。）及び前記実施例により製造した直径４０μmのバンプ（図中においては凹凸状バンプと記載している。）をそれぞれアルミニウムよりなる厚さ１μmの検査用電極にバンプ１個当たり１０ｇの加圧力で押し付けた場合の接触抵抗を測定したものである。尚、測定電流は１ｍＡである。図８から明らかなように、前記実施例のバンプの場合には従来例のバンプの場合に比べて接触抵抗が大きく低減している。

【００５７】

【発明の効果】請求項１の発明に係るプローブカードの製造方法によると、押圧用基板の表面層に形成されたバンプの半分以下の径の凸部又は凹部がバンプの先端面に転写されるため、バンプの先端面には均一な凹凸部が形成されるので、プローブカードを半導体ウェハに押し付けると、半導体チップのすべての検査用電極の表面酸化膜が確実に破られるので、プローブカードのバンプと半導体チップの検査用電極との良好な電気的接続が得られる。

【００５８】また、押圧用基板の表面層に形成された凹部及び凸部はバンプよりも硬い材料により構成されているため、１回の押し付けでは殆ど変形が見られず、１枚の押圧用基板を繰り返し使用することができる。従って、繰り返し使用することができる押圧用基板をバンプに押し付けるのみで、バンプの先端に均一な凹凸を形成することができるので、プローブカードの低コスト化が図れる。

【００５９】請求項２の発明に係るプローブカードの製造方法によると、押圧用基板の表面層にはメッキ法により均一で且つ所望の大きさの径のＮｉ、Ｒｈ、Ｐｄ又はWよりなる粒子が形成されているため、バンプの先端面に均一で所望の大きさの凹凸部を形成できるので、半導体チップのすべての検査用電極の表面酸化膜をより確実

に破ることができる。

【００６０】請求項３の発明に係るプローブカードの製造方法によると、押圧用基板の表面層には均一で且つ所望の大きさの径の粒子が接着されているため、バンプの先端面に均一で所望の大きさの凹凸部を形成できるので、半導体チップのすべての検査用電極の表面酸化膜をより確実に破ることができる。

【００６１】請求項４の発明に係るプローブカードの製造方法によると、バンプの表面にバンプよりも硬い金属よりなるメッキ層が形成されているため、バンプ先端面の凹凸部は摩耗し難くなるので、プローブカードのバンプの寿命が長くなる。

【００６２】請求項５の発明に係るプローブカードの製造方法によると、バンプの先端に押圧用基板の表面を位置をずらしながら２回以上押し付けるため、均一で所望の大きさの径を有する凹凸部をバンプの先端に形成できるので、半導体チップのすべての検査用電極の表面酸化膜をより確実に破ることができる。

【００６３】請求項６の発明に係るプローブカードの製造方法によると、配線基板の層間絶縁膜はバンプの先端が同一平面上に位置するように塑性変形しているため、プローブカードのすべてのバンプと半導体チップのすべての検査用電極とが確実に接続されるので、良好にバーンインを行なうことができる。

【図面の簡単な説明】

【図１】本発明の一実施例に係るプローブカードの製造方法の各工程を説明する断面図である。

【図２】前記一実施例に係るプローブカードの製造方法において金属板の表面に形成されたＮｉ粒子よりなる薄膜の写真である。

【図３】前記一実施例に係るプローブカードの製造方法の各工程を説明する断面図である。

【図４】本発明を評価するために行なった評価テストの＊方法を示す断面図である。

【図５】従来のプローブカードの製造方法により形成されたバンプをアルミニウム電極に押し付けたときの圧痕の形状を示す薄膜の写真である。

【図６】前記一実施例に係るプローブカードの製造方法により形成されたバンプの表面の薄膜の写真、前記バンプをアルミニウム電極に押し付けたときの圧痕の形状を示す薄膜の写真及びそのスケッチである。

【図７】前記一実施例に係るプローブカードの製造方法により形成されたバンプの表面の薄膜の写真、前記バンプをアルミニウム電極に押し付けたときの圧痕の形状を示す薄膜の写真及びそのスケッチである。

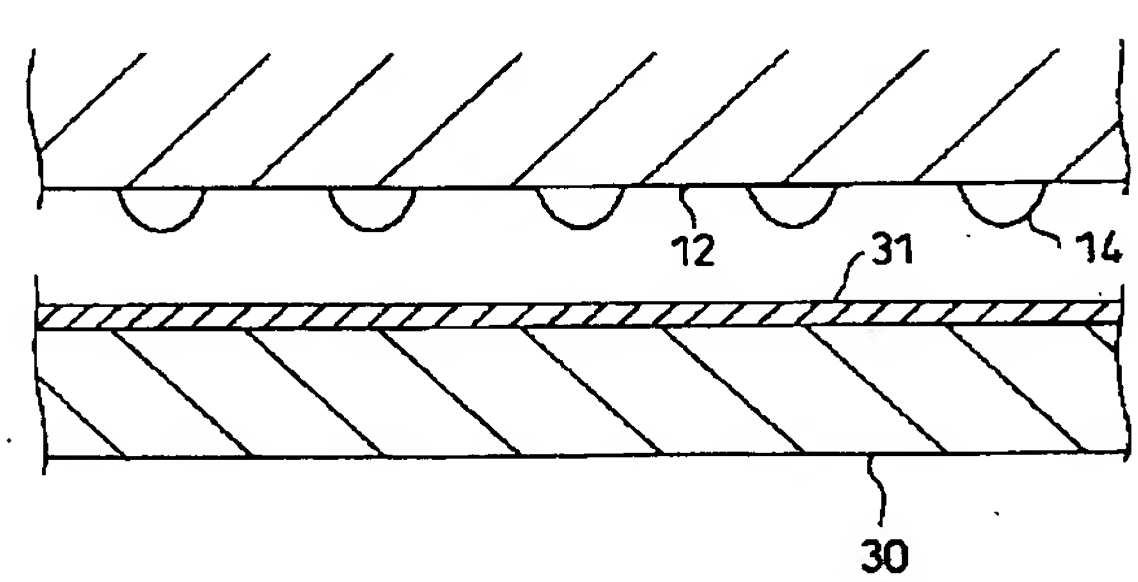
【図８】従来及び本発明の一実施例に係るプローブカードの製造方法により形成されたバンプの形状と接触抵抗との関係を示す図である。

【図９】前記一実施例に係るプローブカードの製造方法の各工程を説明する断面図である。

【符号の説明】

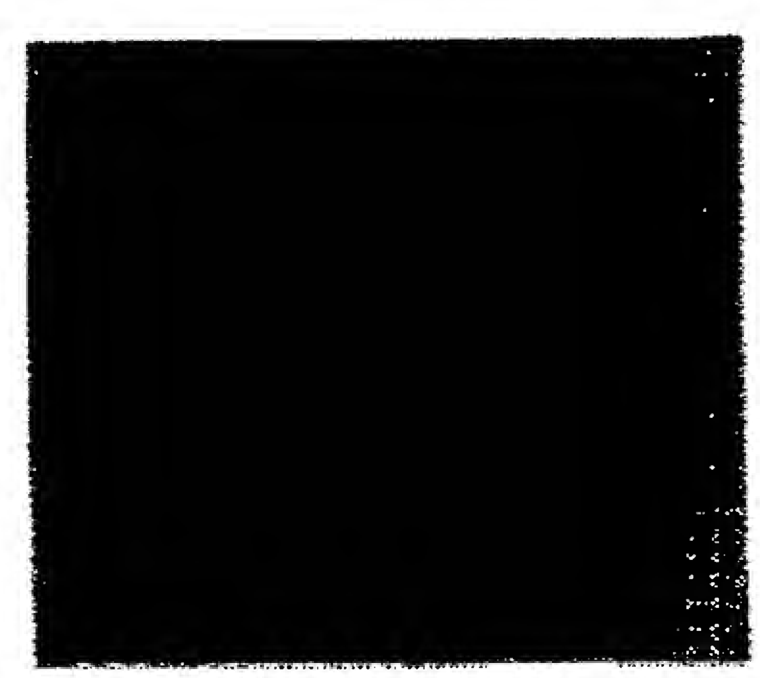
１０　銅箔
１１　ポリイミド層
１２　フレキシブル基板
１３　スルーホール
１４　バンプ
２０　金属板
２１　メッキ層
３０　アルミニウム電極
３１　アルミナ層
４１　ガラス基板
４２　金属配線
４３　層間絶縁膜
４４　金属電極
４５　バンプ
４６　基板

【図４】

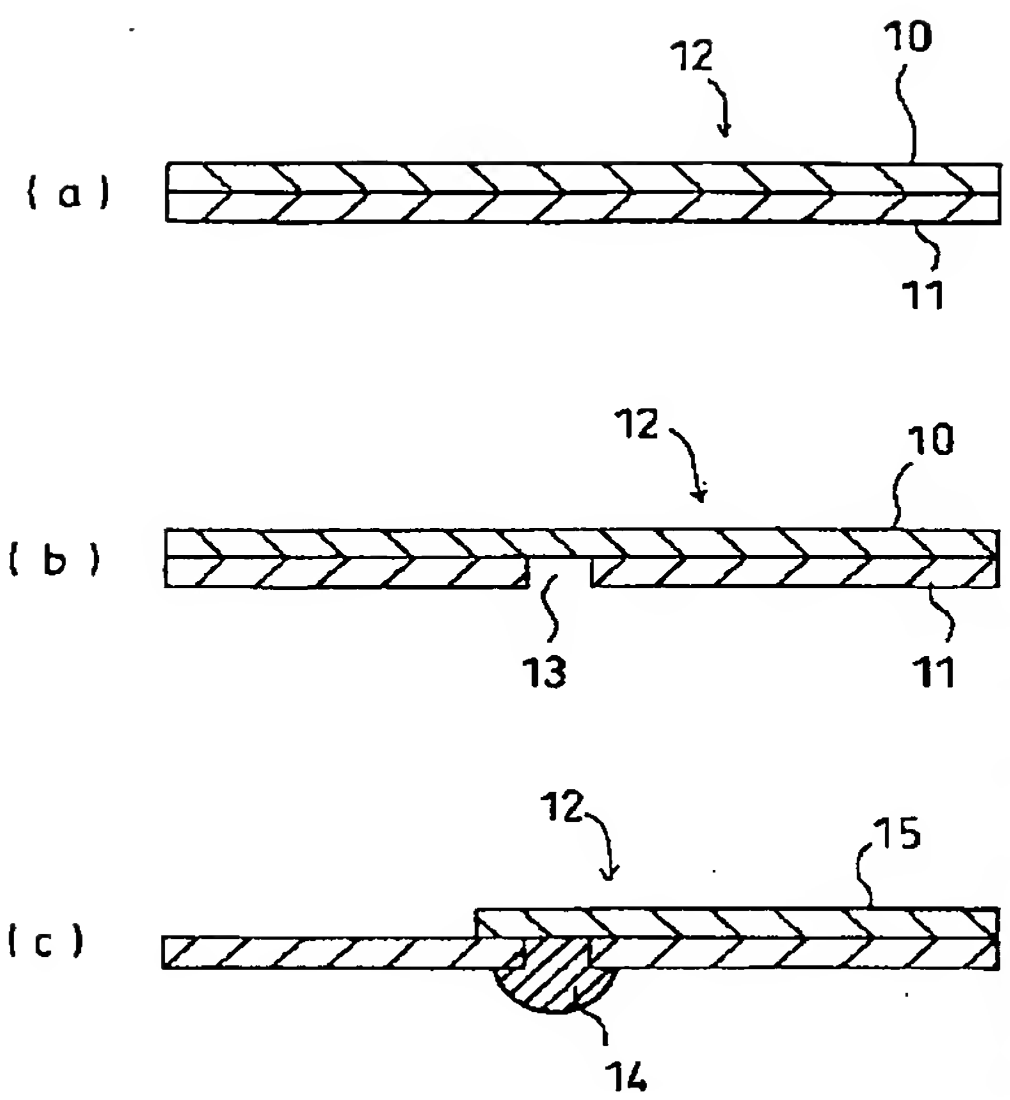


【図５】

図面代用写真

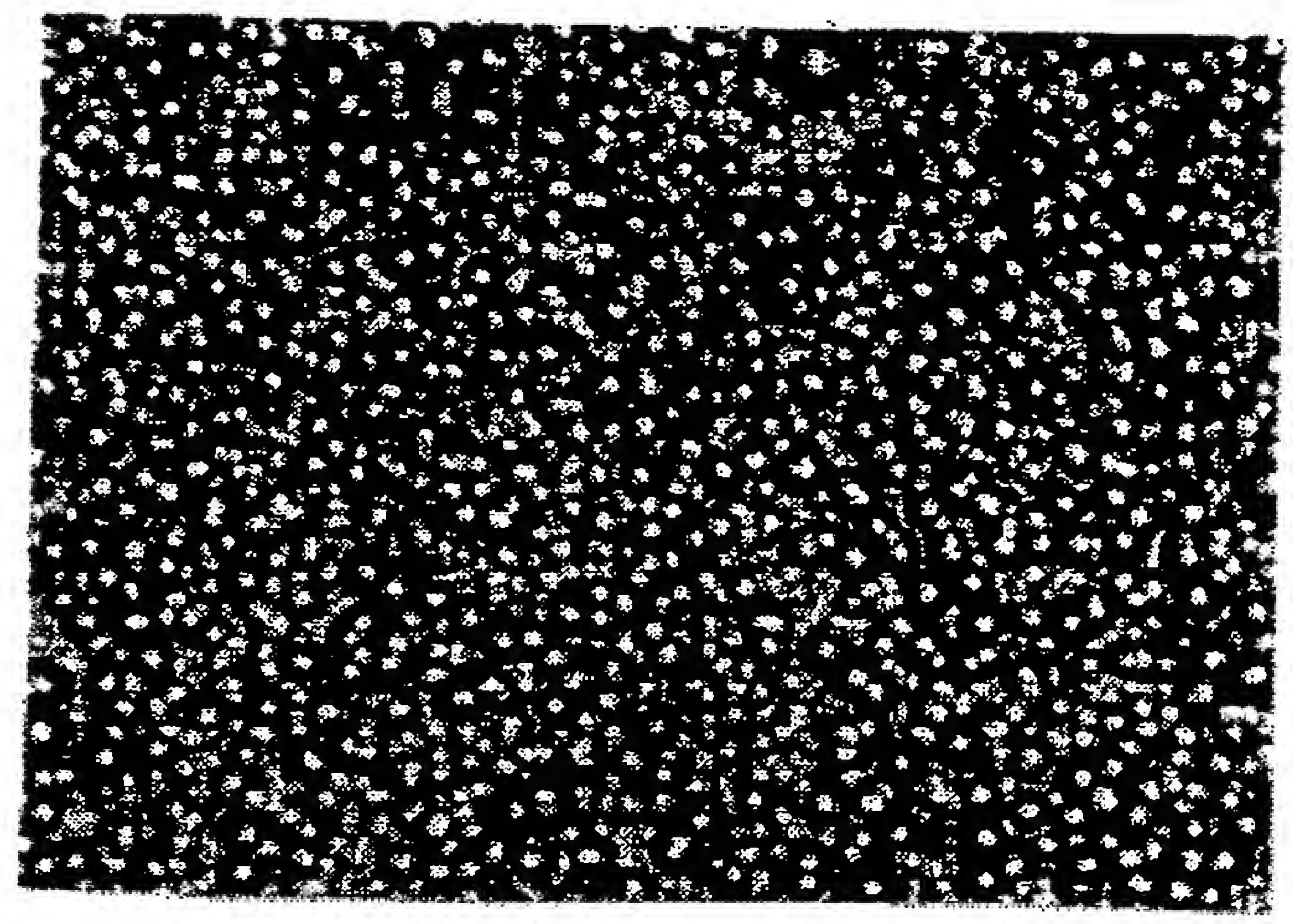


【図1】

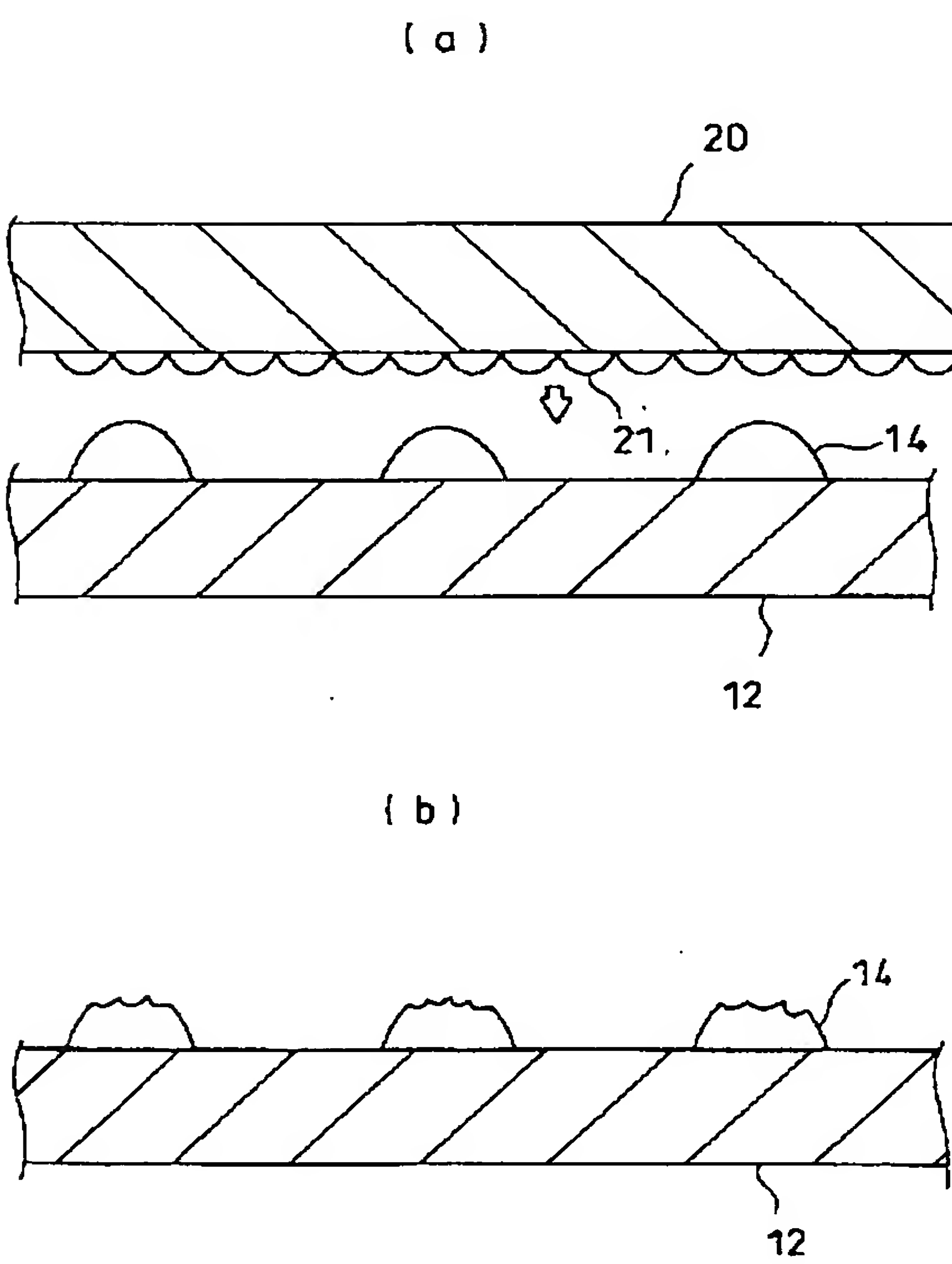


【図2】

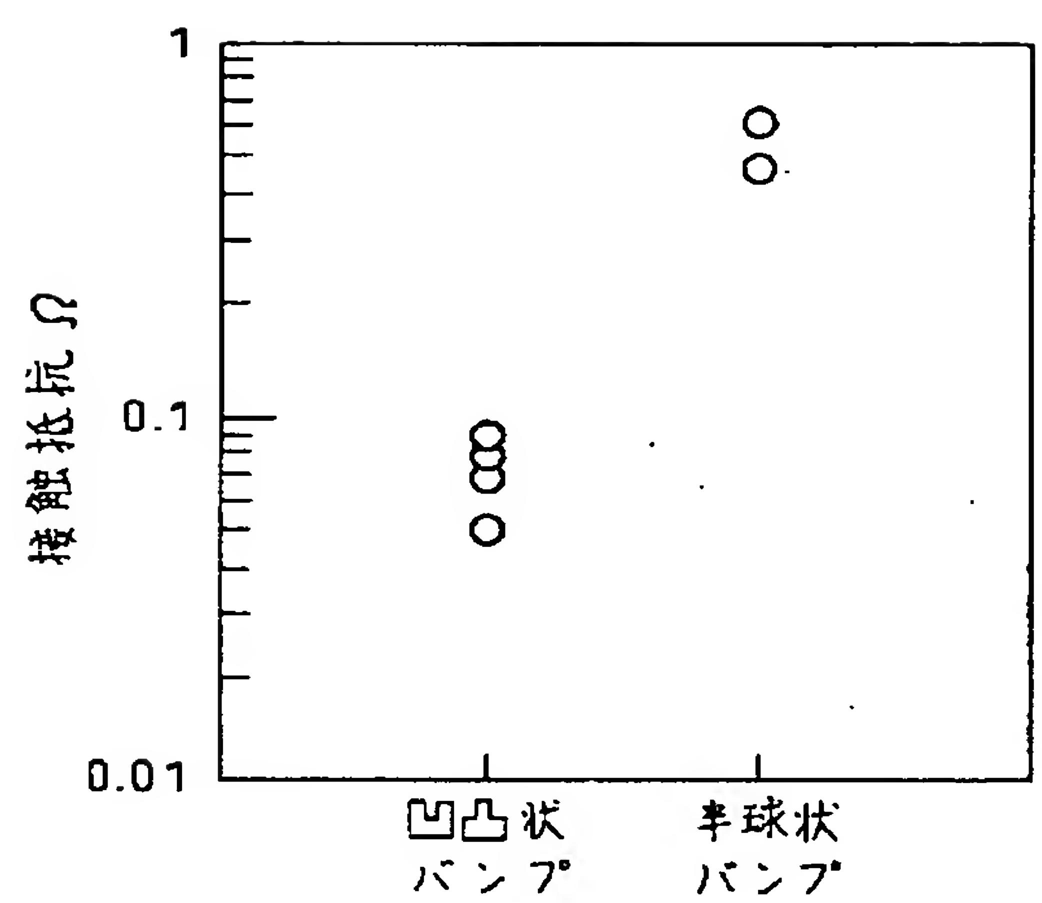
図面代用写真



【図3】

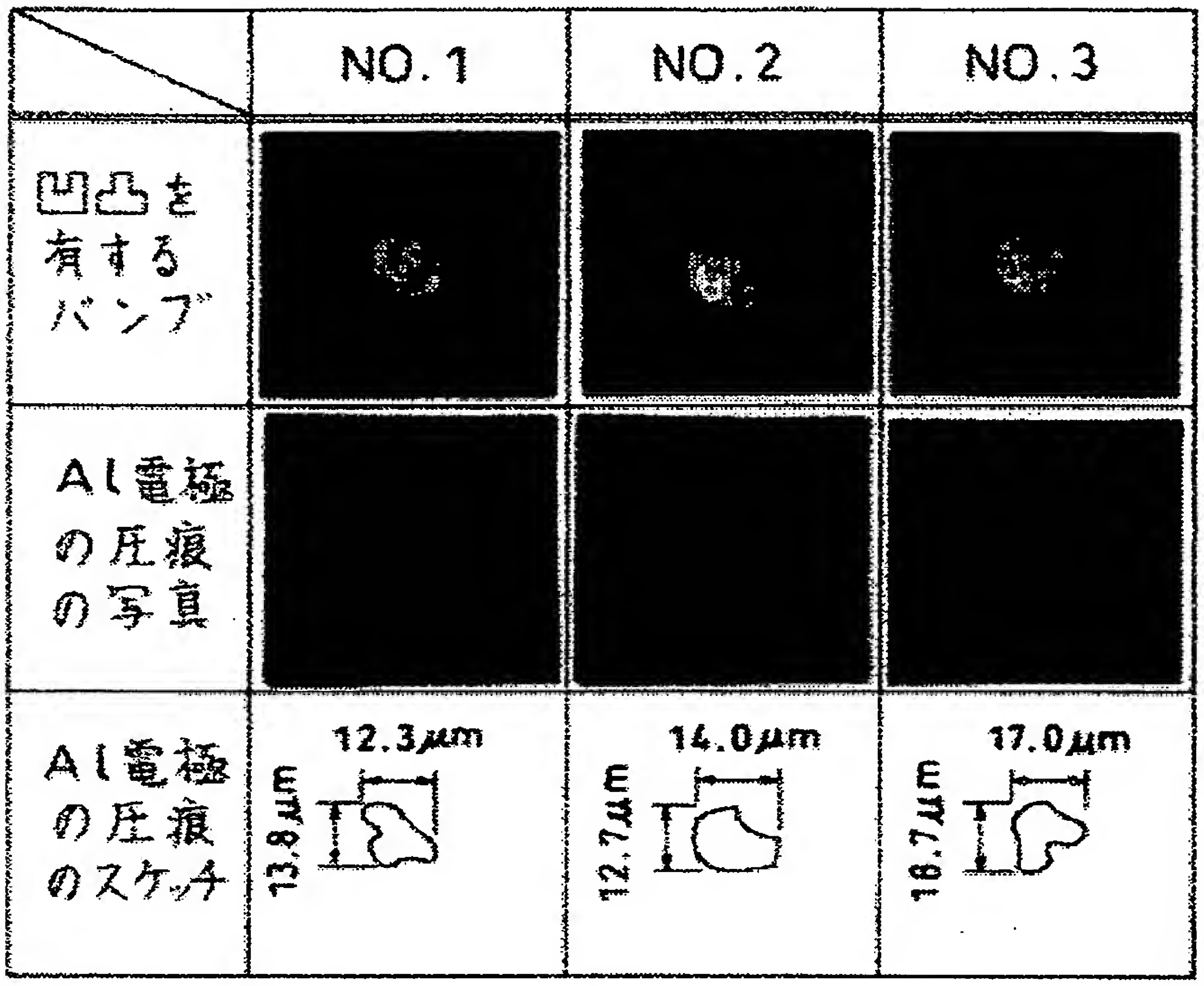


【図8】

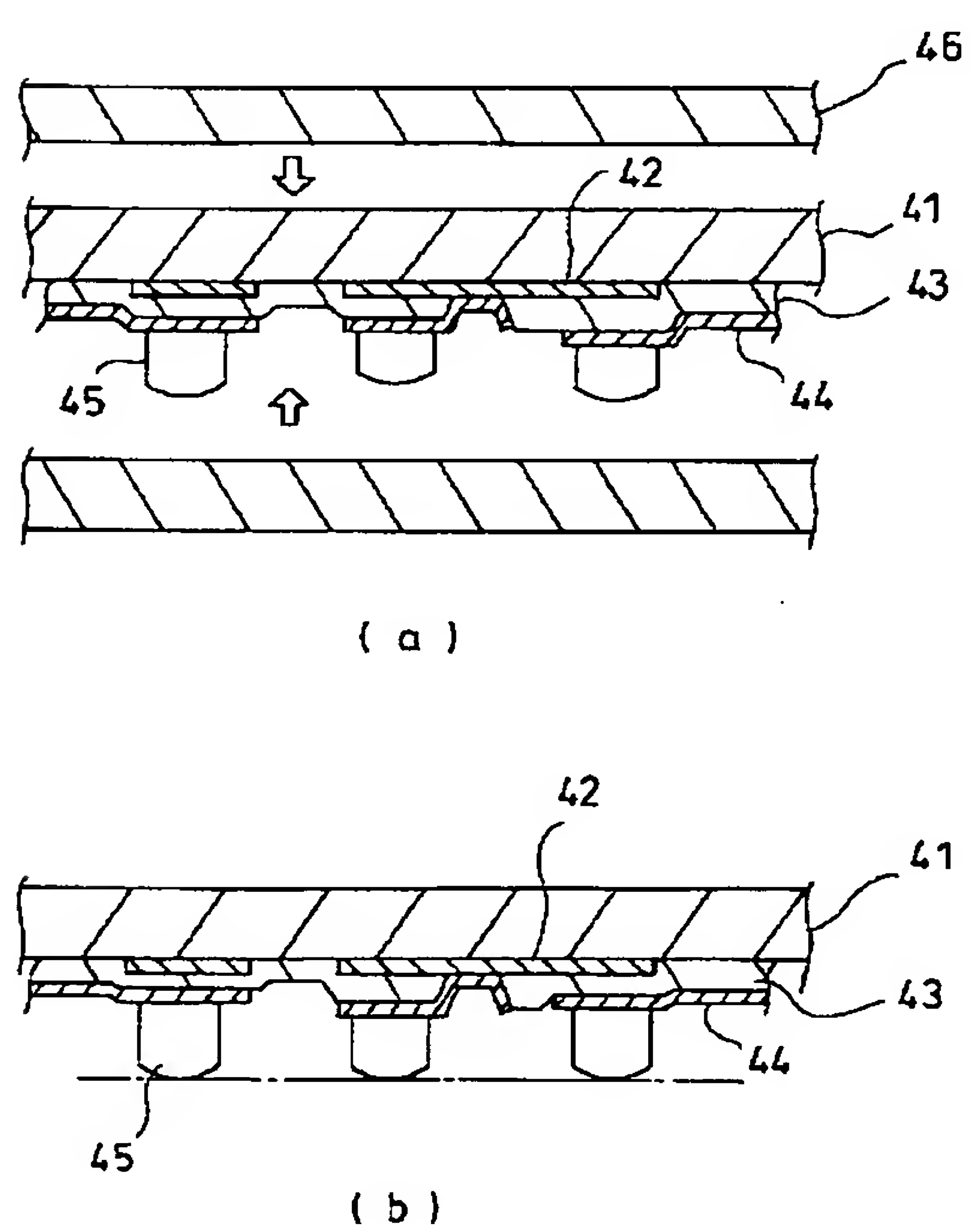


【図6】

図面代用写真

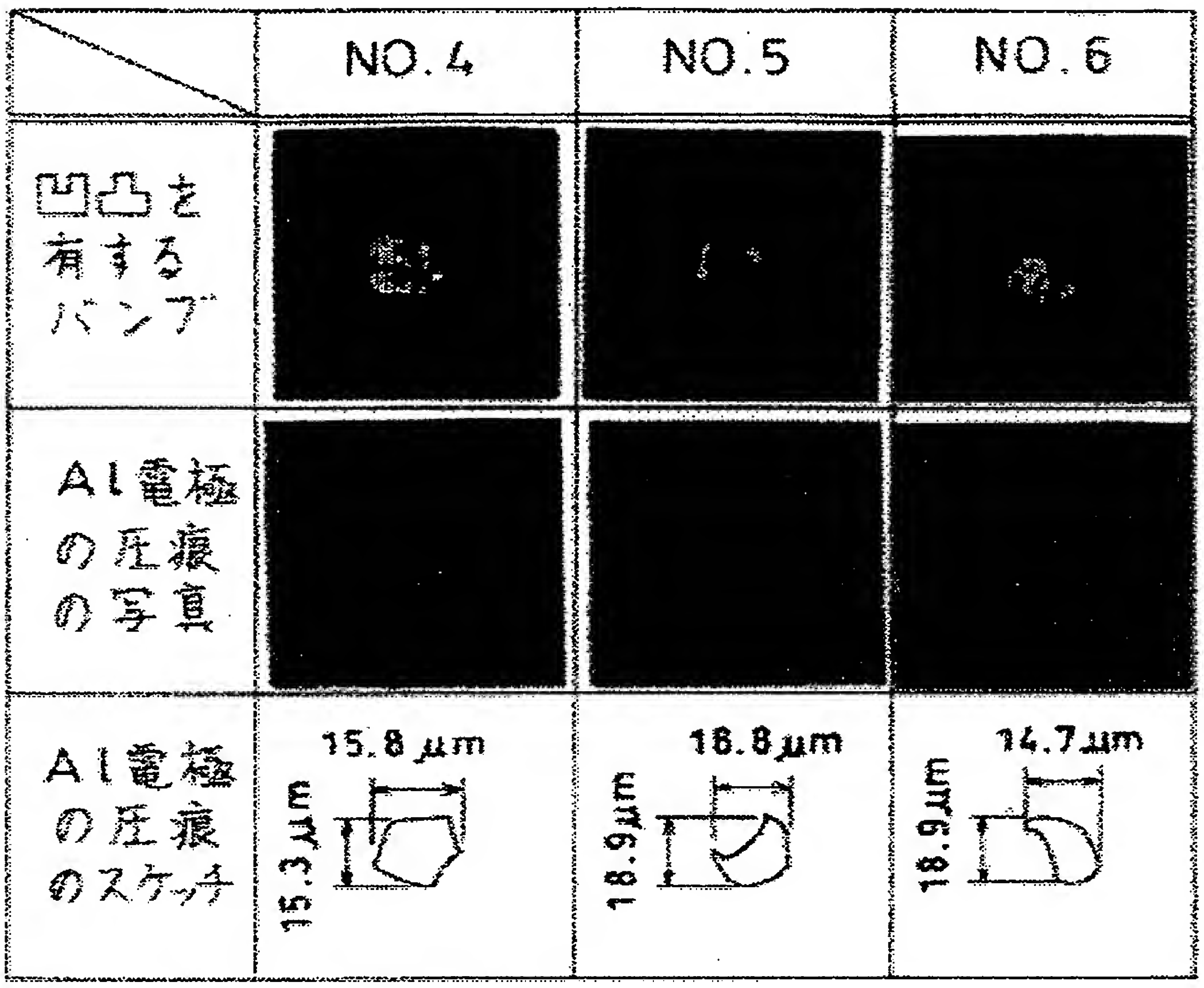

NO.1
NO.2
NO.3
凹凸を有するバンプ
Al電極の圧痕の写真
Al電極の圧痕のスケッチ
12.3μm
13.8μm
14.0μm
12.7μm
17.0μm
16.7μm

【図9】


46
42
41
43
45
44
(a)
42
41
43
44
45
(b)

【図７】

図面代用写真



NO.4
NO.5
NO.6
凹凸を有するバンプ
Al電極の圧痕の写真
Al電極の圧痕のスケッチ
15.8 μm
15.3 μm
18.8 μm
18.9 μm
14.7 μm
18.9 μm

PATENT ABSTRACTS OF JAPAN

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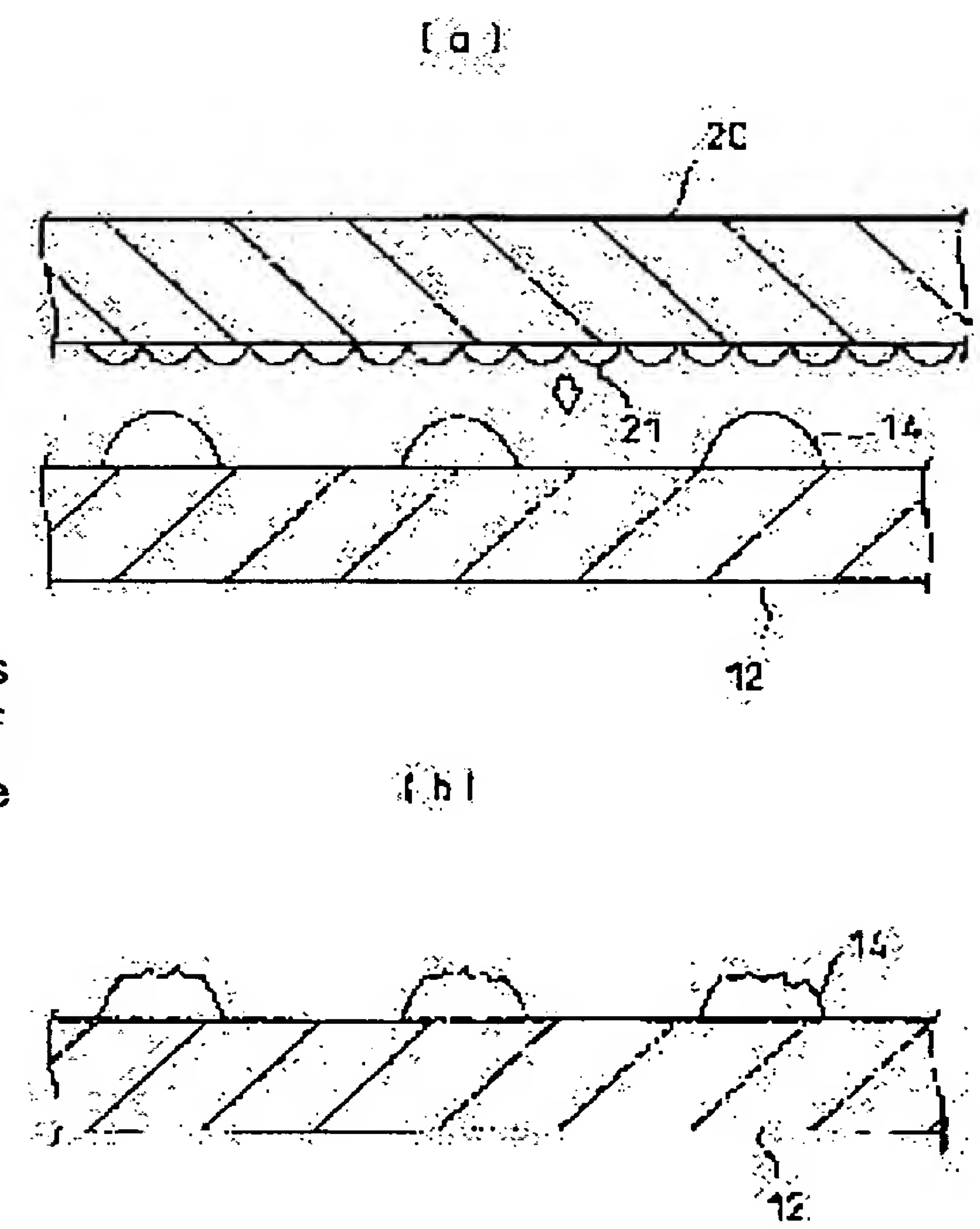
OKI SHINICHI

(54) PRODUCTION OF PROBE CARD

(57)Abstract:
PURPOSE: To break oxide deposited on the surface of inspection electrode of a semiconductor chip surely by forming irregularities uniformly on the top surface of a bump.
CONSTITUTION: Bumps to be connected with the inspection electrodes of a semiconductor chip are formed on the surface of a flexible board. A plating layer 21 of harder material than the bump 14 on the flexible board 12 provided with protrusions or recesses having diameter equal to or less than one half of the bump 14 is then formed a flat metal plate 20. The plating layer 21 of the flat metal plate 20 is pressed against the top surface of bumps 14 thus forming irregularities on the top surface of bumps 14.



LEGAL STATUS

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[Date of final disposal for application]	
[Patent number]	2796070
[Date of registration]	26.06.1998
[Number of appeal against examiner's decision of rejection]	

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The process which is the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, and forms in the front face of a wiring substrate the bump connected with the checking electrode of said semiconductor chip, The process which forms the surface layer which becomes a substrate for press from an ingredient harder than said bump, and has the heights or the crevice of a path below one half of said bump's path, and by forcing the surface layer of said substrate for press on said bump's apical surface The manufacture approach of the probe card characterized by having the process which forms concave heights in said bump's apical surface.
[Claim 2] The process which forms said surface layer in said substrate for press is the metal particles or the ceramics which becomes the front face of said substrate for press from nickel, Rh, Pd, or W with plating, or SiO2. The manufacture approach of the probe card according to claim 1 characterized by including the process which forms the becoming particle.
[Claim 3] The process which forms said surface layer in said substrate for press is the manufacture approach of the probe card according to claim 1 characterized by including the process which fixes to the front face of said substrate for press the particle which consists of nickel, Rh, Pd, or W with adhesives.
[Claim 4] The manufacture approach of a probe card given in any 1 term of claims 1-3 characterized by having the process which forms the deposit which consists of a metal harder than this bump in said bump's front face on which concave heights were formed in the apical surface.
[Claim 5] It is the manufacture approach of a probe card given in any 1 term of claims 1-4 characterized by changing the location of said substrate for press which the count of forcing is 2 times or more in the process which forces the surface layer of said substrate for press on said bump's apical surface, and contacts said bump whenever it pushes once.
[Claim 6] The wiring substrate which is the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, and has an interlayer insulation film between lower layer metal wiring and the upper metal electrode or between a base material and said metal electrode, Where the bump who is formed and is connected with the checking electrode of said semiconductor chip so that it may connect with the metal electrode of said upper layer electrically is held at the temperature which said interlayer insulation film softens The manufacture approach of the probe card characterized by having the process which said bump's tip is forced [process] on a flat substrate, and locates said bump's tip on the same flat surface.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the manufacture approach of the probe card for the integrated circuit of two or more semiconductor chips formed on the semi-conductor wafer being put in block in the state of a wafer, and inspecting it.
[0002]
[Description of the Prior Art] In recent years, the demand of a miniaturization of as opposed to [in connection with **** better ** and this] a semiconductor device in the advance of the miniaturization of electronic equipment which carried semiconductor integrated circuit equipment (a semiconductor device is called henceforth.), and low-pricing, and low-pricing is strong.
[0003] Usually, after a semiconductor chip and a leadframe are electrically connected by the bonding wire, a semiconductor device is supplied after the closure of a semiconductor chip and the leadframe has been carried out by resin or ceramics, and is mounted in a printed circuit board. However, to supply the bare chip with which the method of mounting a semiconductor device in the circuit board directly in the condition [having started from the semi-conductor wafer] (the semiconductor device of this condition being henceforth called a bare chip.) was developed, and quality was guaranteed from the demand of a miniaturization of electronic equipment by the low price is desired.
[0004] In order to guarantee the quality to a bare chip, it is necessary to inspect a burn-in etc. in the state of a wafer to a semiconductor device. however, two or more bare chips currently formed on the semi-conductor wafer -- receiving -- one piece -- or -- some -- every -- since much time amount is required, in time, it is not realistic in cost to inspect by dividing into numbers of times. Then, it is required that it should bundle up in the state of a wafer to all bare chips, and a burn-in etc. should be inspected.
[0005] In order to inspect by bundling up in the state of a wafer to a bare chip, it is necessary to impress supply voltage and a signal to the checking electrode of two or more semiconductor chips formed on the semi-conductor wafer at coincidence, and to operate these two or more semiconductor chips. for this reason -- being alike -- although it is necessary to prepare a probe card with a probe needle [many / very / (usually thousands of or more pieces)], in order to do in this way, with the conventional needle mold probe card, it cannot respond [point / of a price] from the point of the number of pins, either.
[0006] Then, the contactor which consists of a probe card of the thin film mold with which the bump connected with the checking electrode of a semiconductor chip was prepared on the flexible wiring substrate is proposed (Japanese east technical report [Vol.28, No.2 (see Oct.1990 PP.57-62)]).
[0007] Hereafter, the inspection approach of the semiconductor device performed using the manufacture approach of the aforementioned probe card and this probe card is explained.
[0008] First, after forming an insulating layer on the surface of a metallic foil and forming a through hole in this insulating layer, one side of the electrode for plating is connected to a metallic foil, and electroplating is performed. If a deposit is attained to the front face of an insulating layer after it progresses so that a through hole may be filled, it will spread isotropic on

this front face, and will become semi-sphere-like. The deposit of the shape of this semi-sphere is a checking bump. Then, it etches to a metallic foil, a circuit pattern is formed, and a probe card is manufactured.
[0009] Next, after performing alignment of a probe card and a semi-conductor wafer, a probe card is pushed against a semi-conductor wafer, the bump of a probe card is contacted to the checking electrode of a semiconductor chip, after that, supply voltage and a signal level are impressed to a bump, and a semiconductor device is inspected.
[0010] By the way, since the checking electrode of a semiconductor chip is formed with the metal which is [aluminum] usually easy to oxidize, the front face of a checking electrode is covered with scaling film, such as an alumina. Then, in order to obtain the good electrical installation of the bump of a probe card, and the checking electrode of a semiconductor chip, it is necessary to press a probe card to a semi-conductor wafer, and to tear the scaling film by this thrust.
[0011]
[Problem(s) to be Solved by the Invention] However, if the number of the semiconductor chips formed in a semi-conductor wafer increases, the number of bumps formed in a probe card increases, and the thrust applied to per bump cannot but decrease. For this reason, it becomes impossible to tear the scaling film certainly by the bump, and there is a problem that variation arises in the contact resistance between a bump and a checking electrode.
[0012] Then, by making the touch area of a bump and a checking electrode small, even when the thrust applied to per bump was fixed, the load per unit touch area became large, and thereby, these artificers took into consideration making it the scaling film of a checking electrode torn certainly.
[0013] Specifically, the approach of forming irregularity with plating on the surface of a bump, the approach of etching into a bump's front face and forming irregularity, the approach of embedding a detailed particle on a bump's front face, and forming irregularity, etc. were taken into consideration as a policy for enlarging the load per unit touch area.
[0014] However, there is the 1st problem that uniform irregularity can be formed in low cost by neither of the approaches at a bump's apical surface.
[0015] Moreover, to a semi-conductor wafer being very flat, since the surface smoothness of a probe card is not enough, a bump's tip is not located on the same flat surface in many cases. For this reason, when the diameter of a semi-conductor wafer becomes large and the number of semiconductor chips increases, there is the 2nd problem that none of the bumps of a probe card and all the checking electrodes of a semiconductor chip is connected certainly.
[0016] In view of the above, this invention can form uniform irregularity in low cost at a bump's apical surface. By this It makes making it the scaling film of the checking electrode of a semiconductor chip torn certainly into the 1st purpose, and the tip of all the bumps of a probe card is located on the same flat surface. By this It sets it as the 2nd purpose that all the bumps of a probe card and all the checking electrodes of a semiconductor chip are connected certainly.

[0017]
[Means for Solving the Problem] In order to attain the 1st aforementioned purpose, invention of claim 1 forms irregularity in a bump's apical surface by forcing a bump's apical surface on the substrate which has the concave heights which consist of an ingredient harder than a bump.
[0018] The solution means which invention of claim 1 provided concretely The process which forms in the front face of a wiring substrate the bump connected with the checking electrode of said semiconductor chip for the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, The process which forms the surface layer which becomes a substrate for press from an ingredient harder than said bump, and has the heights or the crevice of a path below one half of said bump's path, and by forcing the surface layer of said substrate for press on said bump's apical surface It considers as a configuration equipped with the process which forms concave heights in said bump's apical surface.
[0019] The process at which invention of claim 2 forms said surface layer in said substrate for

press at the configuration of claim 1 is the metal particles or the ceramics which becomes the front face of said substrate for press from nickel, Rh, Pd, or W with plating, or SiO2. A configuration including the process which forms the becoming particle is added.
[0020] The process at which invention of claim 3 forms said surface layer in said substrate for press at the configuration of claim 1 adds a configuration including the process which fixes to the front face of said substrate for press the particle which consists of nickel, Rh, Pd, or W with adhesives.
[0021] Invention of claim 4 adds the configuration which equips the configuration of claims 1-3 with the process which forms the deposit which consists of a metal harder than this bump in said bump's front face on which concave heights were formed in the apical surface.
[0022] In the process at which invention of claim 5 forces the surface layer of said substrate for press on said bump's apical surface at the configuration of claims 1-4, the count of forcing is 2 times or more, and whenever it pushes once, it adds the configuration which changes the location of said substrate for press in contact with said bump.
[0023] In order to attain the 2nd aforementioned purpose, invention of claim 6 carries out plastic deformation of the interlayer insulation film so that a bump's tip may be located on the same flat surface.
[0024] The solution means which invention of claim 6 provided concretely The wiring substrate which has an interlayer insulation film between lower layer metal wiring and the upper metal electrode or between a base material and a metal electrode for the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, Where the bump who is formed and is connected with the checking electrode of said semiconductor chip so that it may connect with the metal electrode of said upper layer electrically is held at the temperature which said interlayer insulation film softens It considers as a configuration equipped with the process which said bump's tip is forced [process] on a flat substrate, and locates said bump's tip on the same flat surface.
[0025]
[Function] If the surface layer which consists of an ingredient harder than a bump and has the heights or the crevice of a path below one half of a bump's path by the configuration of claim 1 is forced on a bump's apical surface, since the heights or the crevice of said surface layer will be imprinted by a bump's apical surface, concave heights are formed.
[0026] The metal particles or the ceramics which becomes the front face of the substrate for press from nickel, Rh, Pd, or W with plating by the configuration of claim 2, or SiO2 Since the becoming particle is formed, it is uniform and the concave heights which have the path of desired magnitude can be formed in the front face of the substrate for press.
[0027] Since the particle which consists of nickel, Rh, Pd, or W with adhesives is fixed to the front face of the substrate for press by the configuration of claim 3, it is uniform, and the concave heights which have the path of desired magnitude can be formed in the front face of the substrate for press.
[0028] Since the deposit which consists of a metal harder than a bump is formed in a bump's front face on which concave heights were formed in the apical surface by the configuration of claim 4, the concave heights of a bump apical surface stop being able to wear out easily.
[0029] In order to force the front face of the substrate for press at a bump's tip twice or more by the configuration of claim 5, shifting a location, it is uniform, and the concave heights which have the path of desired magnitude can be formed at a bump's tip.
[0030] If a bump's tip is forced on a flat substrate where the wiring substrate with which the bump was formed is held by the configuration of claim 6 at the temperature which an interlayer insulation film softens, an interlayer insulation film will deform so that a bump's tip may be located on the same flat surface. Then, if the temperature of a flexible substrate is returned to ordinary temperature, an interlayer insulation film will hold and harden the condition that a bump's tip is located on the same flat surface. In this case, since the interlayer insulation film deformed plastically since the temperature which an interlayer insulation film softens was higher than the temperature of a burn-in does not deform again at the time of a burn-in, a burn-in can be performed good.

[0031]
[Example] Hereafter, the manufacture approach of the probe card concerning one example of this invention is explained, referring to drawing 1 and drawing 2 .
[0032] First, the bump connected with the checking electrode of a semiconductor chip is formed in the front face of a flexible wiring substrate.
[0033] As shown in drawing 1 (a), after casting polyimide (or polyimide precursor) for the whole surface of copper foil 10 with a thickness of about 18 micrometers, heat polyimide, it is made to dry and harden, and the polyimide layer 11 is formed. The thickness of the polyimide layer 11 after hardening is about 25 micrometers. the coefficient of thermal expansion of polyimide -- a copper coefficient of thermal expansion (16x10-6/degree C) and abbreviation -- since it is the same, there is little curvature by the heat history of the flexible substrate 12 which consists of copper foil 10 and a polyimide layer 11.
[0034] Then, as shown in drawing 1 (b), the through hole 13 with a diameter of about 30 micrometers is formed in the polyimide layer 11. then, after copper foil 10 is alike on the other hand and applying a resist (illustration is omitted.), one side of the electrode for plating is connected to copper foil 10, and electroplating of nickel is performed. Since the other sides of copper foil 10 are covered with the resist, nickel is not plated. If the front face of the polyimide layer 11 is arrived at after a deposit is formed so that a through hole 13 may be filled, it will spread isotropic, and will become semi-sphere-like, and the bump 14 with a diameter of about 45 micrometers will be formed.
[0035] then, after removing the resist which copper foil 10 was alike on the other hand, and was applied, as shown in drawing 1 (c), it etches to copper foil 10 by the well-known approach, and the circuit pattern 15 is formed.
[0036] Here, as a wiring substrate, the wiring substrate (a hard substrate is called henceforth) which used silicon, glass, the ceramics, or glass epoxy as the base material other than said flexible wiring substrate may be used.
[0037] Next, the surface section which has heights or a crevice in the substrate for press is formed.
[0038] For example, electroplating is performed to the front face of the metal plate which consists of copper, for example, it consists of nickel, and the deposit whose particle size is about 1-10 micrometers is formed as a surface layer. About the particle size of nickel particle in this deposit, it is controllable by changing the additive and current density of plating liquid. That is, in order to usually make small particle size of nickel made to generate by plating, an additive like saccharin is used, but if the addition is lessened, the particle size of nickel will become small. Moreover, the diameter of a grain which makes current density low becomes small, and the diameter of a grain which makes current density high becomes large. Therefore, the deposit which consists of a particle with a particle size of about 1-10 micrometers can be formed by changing the additive and current density of plating liquid.
[0039] Drawing 2 shows the enlargement in which the distribution condition of the particle of nickel plating is shown, and it is the case where particle size is about 5-10 micrometers, and distribution of a particle is dense and has become homogeneity.
[0040] In addition, the front face of the substrate for press which consists of sheet glass may be ground against sand instead of an electroplating method, the concave heights whose particle size is about 1-10 micrometers may be formed, and the particle whose particle size is 1-10 micrometers may be made to adhere to the front face of the substrate for press at homogeneity about the formation approach of a surface layer of having heights or a crevice in the substrate for press.
[0041] Next, the surface layer of the substrate for press is pressed against a bump's 14 apical surface, and concave heights are formed in a bump's 14 apical surface.
[0042] As shown in drawing 3 (a), as shown in drawing 3 (b), concave heights are formed in a bump's 14 apical surface by forcing the deposit 21 with a particle size of 3-10 micrometers formed in the front face of a metal plate 20 to the bump 14 of the flexible substrate 12.
[0043] In the case of Au bump with a diameter of 40 micrometers, welding pressure at this time is per [5-50g] one bump, and if it is made, 15-25g are desirable [welding pressure]. Moreover,

although the count of forcing can form the target concave heights mostly even once, it can fill uniformity more by pushing repeatedly 2 to 3 times. When pushing two or more times, it is good to shift the location of a metal plate 20, whenever it pushes once, and for a bump 14 to take care not to hit the same part of the deposit 21 formed in the front face of a metal plate 20.
[0044] Next, the surface protective coat which becomes a bump's 14 apical surface from a deposit is formed.
[0045] As a class of plating, any of electrolytic plating or electroless deposition are sufficient, and 1 micrometer or less is desirable so that the concave heights which Rh, nickel, Pd, W, etc. harder than nickel as a metallic material which constitutes a deposit were mentioned, and were formed in a bump's 14 apical surface as plating layer thickness may not hide.
[0046] Next, the manufacture approach of the probe card which consists of the hard substrate and bump who used silicon, glass, the ceramics, glass epoxy, etc. for the base material is explained.
[0047] Since the surface smoothness is not enough, a hard substrate is used after performing leveling (flattening). Usually, although the display flatness of a hard substrate changes with the base materials and processes, to the magnitude of a substrate, it is about 0.01 – 1%, and has the irregularity of several 10 micrometers or more with a 150mmx150mm substrate. Moreover, although the variation in bump height changes with the formation approaches, it is about 1-5 micrometers in 150mmx150mm area. Since a probe card cannot call it flatness to a semi-conductor wafer being very flat, the bumps of a probe card and no checking electrode of a semiconductor chip may not connect with coincidence certainly. Then, in order to connect both to coincidence certainly, leveling is performed to a probe card.
[0048] Hereafter, the approach of leveling is explained, referring to drawing 9 .
[0049] First, a metal electrode 44 is further formed through an interlayer insulation film 43 with the metal wiring 42 on a glass substrate 41. An epoxy resin, polyimide resin, etc. are used for an interlayer insulation film 43.
[0050] Next, a bump 45 is formed on a metal electrode 44 using a photosensitive resist etc. This bump's 45 tip is not located on the same flat surface, but produces several 100-micrometer variation from several 10 micrometers. As this key factor, there are variation of the display flatness of a glass substrate 41 and the thickness of an interlayer insulation film 43, variation of a bump's 45 height, etc.
[0051] The probe card which consists of a hard substrate and a bump is heated at about 180 degrees C in the condition of having inserted with the substrate of a flat pair. If it does in this way, the interlayer insulation film between lower layer metal wiring in a probe card and the upper metal electrode or between a base material and a metal electrode becomes soft, and the location at a bump's tip comes to be located on the same flat surface. Then, since the interlayer insulation film was deforming plastically even if it cooled the probe card to ordinary temperature, the location at a bump's tip has been located on the same flat surface.
[0052] The evaluation test hereafter performed in order to evaluate this invention is explained.
[0053] Drawing 4 shows how to push the bump 14 who has concave heights in an apical surface against the alumina layer 31 formed in the front face of the aluminum electrode 30. The forcing load in this case is about 10g per bump.
[0054] Drawing 5 shows the indentation formed in the alumina layer, when the bump of the shape of a conventional semi-sphere is pushed against an aluminum electrode, the hollow of the well-organized configuration is formed in the aluminum electrode, and the alumina layer is not fully torn.
[0055] Drawing 6 – drawing 7 show the indentation formed in the alumina layer, when the bump who manufactured according to said example is pushed against an aluminum electrode, the hollow of a complicated configuration is formed in the aluminum electrode also in which sample of No.1-No.6, and the alumina layer is torn certainly.
[0056] Drawing 8 measures the contact resistance at the time of pushing the bump (it being indicated as the concave convex bump all over drawing.) with a diameter of 40 micrometers who manufactured according to semi-sphere-like a conventional bump (it is indicated as the hemispherical bump all over drawing.) with a diameter of 40 micrometers and said conventional

example against a checking electrode with a thickness of 1 micrometer it is thin from aluminum, respectively with the welding pressure of 10g per bump. In addition, a measurement current is 1mA. In the case of the bump of said example, compared with the case of the bump of the conventional example, contact resistance is decreasing greatly so that clearly from drawing 8 .
[0057]
[Effect of the Invention] Since according to the manufacture approach of the probe card concerning invention of claim 1 the heights or the crevice of a path below one half of the bump formed in the surface layer of the substrate for press is imprinted by a bump's apical surface and uniform concave heights are formed in a bump's apical surface If a probe card is pushed against a semi-conductor wafer, since the scaling film of all the checking electrodes of a semiconductor chip will be torn certainly, the good electrical installation of the bump of a probe card and the checking electrode of a semiconductor chip is obtained.
[0058] Moreover, since the crevice and heights which were formed in the surface layer of the substrate for press are constituted by the ingredient harder than a bump, in one forcing, deformation is hardly seen, but they can repeat and use one substrate for press. Therefore, since irregularity uniform at a bump's tip only by forcing on a bump the substrate for press which can be used repeatedly can be formed, low cost-ization of a probe card can be attained.
[0059] According to the manufacture approach of the probe card concerning invention of claim 2, since the particle which is uniform to the surface layer of the substrate for press, and consists of nickel, Rh, Pd, or W of the path of desired magnitude with plating is formed, it is uniform to a bump's apical surface, and since the concave heights of desired magnitude can be formed, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0060] According to the manufacture approach of the probe card concerning invention of claim 3, to the surface layer of the substrate for press, it is uniform, and since the particle of the path of desired magnitude has pasted up, it is uniform to a bump's apical surface, and since the concave heights of desired magnitude can be formed, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0061] Since according to the manufacture approach of the probe card concerning invention of claim 4 the deposit which consists of a metal harder than a bump on the surface of a bump is formed and the concave heights of a bump apical surface stop being able to wear out easily, the life of the bump of a probe card becomes long.
[0062] Since the front face of the substrate for press is forced at a bump's tip twice or more according to the manufacture approach of the probe card concerning invention of claim 5, shifting a location, it is uniform, and since the concave heights which have the path of desired magnitude can be formed at a bump's tip, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0063] Since according to the manufacture approach of the probe card concerning invention of claim 6 the interlayer insulation film of a wiring substrate is deformed plastically so that a bump's tip may be located on the same flat surface and all the bumps of a probe card and all the checking electrodes of a semiconductor chip are connected certainly, a burn-in can be performed good.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention relates to the manufacture approach of the probe card for the integrated circuit of two or more semiconductor chips formed on the semi-conductor wafer being put in block in the state of a wafer, and inspecting it.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, the demand of a miniaturization of as opposed to [in connection with **** better ** and this] a semiconductor device in the advance of the miniaturization of electronic equipment which carried semiconductor integrated circuit equipment (a semiconductor device is called henceforth.), and low-pricing, and low-pricing is strong.
[0003] Usually, after a semiconductor chip and a leadframe are electrically connected by the bonding wire, a semiconductor device is supplied after the closure of a semiconductor chip and the leadframe has been carried out by resin or ceramics, and is mounted in a printed circuit board. However, to supply the bare chip with which the method of mounting a semiconductor device in the circuit board directly in the condition [having started from the semi-conductor wafer] (the semiconductor device of this condition being henceforth called a bare chip.) was developed, and quality was guaranteed from the demand of a miniaturization of electronic equipment by the low price is desired.
[0004] In order to guarantee the quality to a bare chip, it is necessary to inspect a burn-in etc. in the state of a wafer to a semiconductor device. however, two or more bare chips currently formed on the semi-conductor wafer -- receiving -- one piece -- or -- some -- every -- since much time amount is required, in time, it is not realistic in cost to inspect by dividing into numbers of times. Then, it is required that it should bundle up in the state of a wafer to all bare chips, and a burn-in etc. should be inspected.
[0005] In order to inspect by bundling up in the state of a wafer to a bare chip, it is necessary to impress supply voltage and a signal to the checking electrode of two or more semiconductor chips formed on the semi-conductor wafer at coincidence, and to operate these two or more semiconductor chips. for this reason -- being alike -- although it is necessary to prepare a probe card with a probe needle [many / very / (usually thousands of or more pieces)], in order to do in this way, with the conventional needle mold probe card, it cannot respond [point / of a price] from the point of the number of pins, either.
[0006] Then, the contactor which consists of a probe card of the thin film mold with which the bump connected with the checking electrode of a semiconductor chip was prepared on the flexible wiring substrate is proposed (Japanese east technical report [Vol.28, No.2 (see Oct.1990 PP.57-62)]).
[0007] Hereafter, the inspection approach of the semiconductor device performed using the manufacture approach of the aforementioned probe card and this probe card is explained.
[0008] First, after forming an insulating layer on the surface of a metallic foil and forming a through hole in this insulating layer, one side of the electrode for plating is connected to a metallic foil, and electroplating is performed. If a deposit is attained to the front face of an insulating layer after it progresses so that a through hole may be filled, it will spread isotropic on this front face, and will become semi-sphere-like. The deposit of the shape of this semi-sphere is a checking bump. Then, it etches to a metallic foil, a circuit pattern is formed, and a probe card is manufactured.
[0009] Next, after performing alignment of a probe card and a semi-conductor wafer, a probe card is pushed against a semi-conductor wafer, the bump of a probe card is contacted to the checking electrode of a semiconductor chip, after that, supply voltage and a signal level are

impressed to a bump, and a semiconductor device is inspected.

[0010] By the way, since the checking electrode of a semiconductor chip is formed with the metal which is [aluminum] usually easy to oxidize, the front face of a checking electrode is covered with scaling film, such as an alumina. Then, in order to obtain the good electrical installation of the bump of a probe card, and the checking electrode of a semiconductor chip, it is necessary to press a probe card to a semi-conductor wafer, and to tear the scaling film by this thrust.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] Since according to the manufacture approach of the probe card concerning invention of claim 1 the heights or the crevice of a path below one half of the bump formed in the surface layer of the substrate for press is imprinted by a bump's apical surface and uniform concave heights are formed in a bump's apical surface If a probe card is pushed against a semi-conductor wafer, since the scaling film of all the checking electrodes of a semiconductor chip will be torn certainly, the good electrical installation of the bump of a probe card and the checking electrode of a semiconductor chip is obtained.
[0058] Moreover, since the crevice and heights which were formed in the surface layer of the substrate for press are constituted by the ingredient harder than a bump, in one forcing, deformation is hardly seen, but they can repeat and use one substrate for press. Therefore, since irregularity uniform at a bump's tip only by forcing on a bump the substrate for press which can be used repeatedly can be formed, low cost-ization of a probe card can be attained.
[0059] According to the manufacture approach of the probe card concerning invention of claim 2, since the particle which is uniform to the surface layer of the substrate for press, and consists of nickel, Rh, Pd, or W of the path of desired magnitude with plating is formed, it is uniform to a bump's apical surface, and since the concave heights of desired magnitude can be formed, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0060] According to the manufacture approach of the probe card concerning invention of claim 3, to the surface layer of the substrate for press, it is uniform, and since the particle of the path of desired magnitude has pasted up, it is uniform to a bump's apical surface, and since the concave heights of desired magnitude can be formed, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0061] Since according to the manufacture approach of the probe card concerning invention of claim 4 the deposit which consists of a metal harder than a bump on the surface of a bump is formed and the concave heights of a bump apical surface stop being able to wear out easily, the life of the bump of a probe card becomes long.
[0062] Since the front face of the substrate for press is forced at a bump's tip twice or more according to the manufacture approach of the probe card concerning invention of claim 5, shifting a location, it is uniform, and since the concave heights which have the path of desired magnitude can be formed at a bump's tip, the scaling film of all the checking electrodes of a semiconductor chip can be torn more certainly.
[0063] Since according to the manufacture approach of the probe card concerning invention of claim 6 the interlayer insulation film of a wiring substrate is deformed plastically so that a bump's tip may be located on the same flat surface and all the bumps of a probe card and all the checking electrodes of a semiconductor chip are connected certainly, a burn-in can be performed good.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, if the number of the semiconductor chips formed in a semi-conductor wafer increases, the number of bumps formed in a probe card increases, and the thrust applied to per bump cannot but decrease. For this reason, it becomes impossible to tear the scaling film certainly by the bump, and there is a problem that variation arises in the contact resistance between a bump and a checking electrode.
[0012] Then, by making the touch area of a bump and a checking electrode small, even when the thrust applied to per bump was fixed, the load per unit touch area became large, and thereby, these artificers took into consideration making it the scaling film of a checking electrode torn certainly.
[0013] Specifically, the approach of forming irregularity with plating on the surface of a bump, the approach of etching into a bump's front face and forming irregularity, the approach of embedding a detailed particle on a bump's front face, and forming irregularity, etc. were taken into consideration as a policy for enlarging the load per unit touch area.
[0014] However, there is the 1st problem that uniform irregularity can be formed in low cost by neither of the approaches at a bump's apical surface.
[0015] Moreover, to a semi-conductor wafer being very flat, since the surface smoothness of a probe card is not enough, a bump's tip is not located on the same flat surface in many cases. For this reason, when the diameter of a semi-conductor wafer becomes large and the number of semiconductor chips increases, there is the 2nd problem that none of the bumps of a probe card and all the checking electrodes of a semiconductor chip is connected certainly.
[0016] In view of the above, this invention can form uniform irregularity in low cost at a bump's apical surface. By this It makes making it the scaling film of the checking electrode of a semiconductor chip torn certainly into the 1st purpose, and the tip of all the bumps of a probe card is located on the same flat surface. By this It sets it as the 2nd purpose that all the bumps of a probe card and all the checking electrodes of a semiconductor chip are connected certainly.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the 1st aforementioned purpose, invention of claim 1 forms irregularity in a bump's apical surface by forcing a bump's apical surface on the substrate which has the concave heights which consist of an ingredient harder than a bump.
[0018] The solution means which invention of claim 1 provided concretely The process which forms in the front face of a wiring substrate the bump connected with the checking electrode of said semiconductor chip for the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, The process which forms the surface layer which becomes a substrate for press from an ingredient harder than said bump, and has the heights or the crevice of a path below one half of said bump's path, and by forcing the surface layer of said substrate for press on said bump's apical surface It considers as a configuration equipped with the process which forms concave heights in said bump's apical surface.
[0019] The process at which invention of claim 2 forms said surface layer in said substrate for press at the configuration of claim 1 is the metal particles or the ceramics which becomes the front face of said substrate for press from nickel, Rh, Pd, or W with plating, or SiO2. A configuration including the process which forms the becoming particle is added.
[0020] The process at which invention of claim 3 forms said surface layer in said substrate for press at the configuration of claim 1 adds a configuration including the process which fixes to the front face of said substrate for press the particle which consists of nickel, Rh, Pd, or W with adhesives.
[0021] Invention of claim 4 adds the configuration which equips the configuration of claims 1-3 with the process which forms the deposit which consists of a metal harder than this bump in said bump's front face on which concave heights were formed in the apical surface.
[0022] In the process at which invention of claim 5 forces the surface layer of said substrate for press on said bump's apical surface at the configuration of claims 1-4, the count of forcing is 2 times or more, and whenever it pushes once, it adds the configuration which changes the location of said substrate for press in contact with said bump.
[0023] In order to attain the 2nd aforementioned purpose, invention of claim 6 carries out plastic deformation of the interlayer insulation film so that a bump's tip may be located on the same flat surface.
[0024] The solution means which invention of claim 6 provided concretely The wiring substrate which has an interlayer insulation film between lower layer metal wiring and the upper metal electrode or between a base material and a metal electrode for the manufacture approach of the probe card for inspecting the electrical property of the semiconductor chip formed on the semi-conductor wafer, Where the bump who is formed and is connected with the checking electrode of said semiconductor chip so that it may connect with the metal electrode of said upper layer electrically is held at the temperature which said interlayer insulation film softens It considers as a configuration equipped with the process which said bump's tip is forced [process] on a flat substrate, and locates said bump's tip on the same flat surface.

[Translation done.]

OPERATION

[Function] If the surface layer which consists of an ingredient harder than a bump and has the heights or the crevice of a path below one half of a bump's path by the configuration of claim 1 is forced on a bump's apical surface, since the heights or the crevice of said surface layer will be imprinted by a bump's apical surface, concave heights are formed.
[0026] The metal particles or the ceramics which becomes the front face of the substrate for press from nickel, Rh, Pd, or W with plating by the configuration of claim 2, or SiO2 Since the becoming particle is formed, it is uniform and the concave heights which have the path of desired magnitude can be formed in the front face of the substrate for press.
[0027] Since the particle which consists of nickel, Rh, Pd, or W with adhesives is fixed to the front face of the substrate for press by the configuration of claim 3, it is uniform, and the concave heights which have the path of desired magnitude can be formed in the front face of the substrate for press.
[0028] Since the deposit which consists of a metal harder than a bump is formed in a bump's front face on which concave heights were formed in the apical surface by the configuration of claim 4, the concave heights of a bump apical surface stop being able to wear out easily.
[0029] In order to force the front face of the substrate for press at a bump's tip twice or more by the configuration of claim 5, shifting a location, it is uniform, and the concave heights which have the path of desired magnitude can be formed at a bump's tip.
[0030] If a bump's tip is forced on a flat substrate where the wiring substrate with which the bump was formed is held by the configuration of claim 6 at the temperature which an interlayer insulation film softens, an interlayer insulation film will deform so that a bump's tip may be located on the same flat surface. Then, if the temperature of a flexible substrate is returned to ordinary temperature, an interlayer insulation film will hold and harden the condition that a bump's tip is located on the same flat surface. In this case, since the interlayer insulation film deformed plastically since the temperature which an interlayer insulation film softens was higher than the temperature of a burn-in does not deform again at the time of a burn-in, a burn-in can be performed good.

[Translation done.]

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EXAMPLE

[Example] Hereafter, the manufacture approach of the probe card concerning one example of this invention is explained, referring to drawing 1 and drawing 2 .
[0032] First, the bump connected with the checking electrode of a semiconductor chip is formed in the front face of a flexible wiring substrate.
[0033] As shown in drawing 1 (a), after casting polyimide (or polyimide precursor) for the whole surface of copper foil 10 with a thickness of about 18 micrometers, heat polyimide, it is made to dry and harden, and the polyimide layer 11 is formed. The thickness of the polyimide layer 11 after hardening is about 25 micrometers. the coefficient of thermal expansion of polyimide -- a copper coefficient of thermal expansion (16x10-6/degree C) and abbreviation -- since it is the same, there is little curvature by the heat history of the flexible substrate 12 which consists of copper foil 10 and a polyimide layer 11.
[0034] Then, as shown in drawing 1 (b), the through hole 13 with a diameter of about 30 micrometers is formed in the polyimide layer 11. then, after copper foil 10 is alike on the other hand and applying a resist (illustration is omitted.), one side of the electrode for plating is connected to copper foil 10, and electroplating of nickel is performed. Since the other sides of copper foil 10 are covered with the resist, nickel is not plated. If the front face of the polyimide layer 11 is arrived at after a deposit is formed so that a through hole 13 may be filled, it will spread isotropic, and will become semi-sphere-like, and the bump 14 with a diameter of about 45 micrometers will be formed.
[0035] then, after removing the resist which copper foil 10 was alike on the other hand, and was applied, as shown in drawing 1 (c), it etches to copper foil 10 by the well-known approach, and the circuit pattern 15 is formed.
[0036] Here, as a wiring substrate, the wiring substrate (a hard substrate is called henceforth) which used silicon, glass, the ceramics, or glass epoxy as the base material other than said flexible wiring substrate may be used.
[0037] Next, the surface section which has heights or a crevice in the substrate for press is formed.
[0038] For example, electroplating is performed to the front face of the metal plate which consists of copper, for example, it consists of nickel, and the deposit whose particle size is about 1-10 micrometers is formed as a surface layer. About the particle size of nickel particle in this deposit, it is controllable by changing the additive and current density of plating liquid. That is, in order to usually make small particle size of nickel made to generate by plating, an additive like saccharin is used, but if the addition is lessened, the particle size of nickel will become small. Moreover, the diameter of a grain which makes current density low becomes small, and the diameter of a grain which makes current density high becomes large. Therefore, the deposit which consists of a particle with a particle size of about 1-10 micrometers can be formed by changing the additive and current density of plating liquid.
[0039] Drawing 2 shows the enlargement in which the distribution condition of the particle of nickel plating is shown, and it is the case where particle size is about 5-10 micrometers, and distribution of a particle is dense and has become homogeneity.
[0040] In addition, the front face of the substrate for press which consists of sheet glass may be

ground against sand instead of an electroplating method, the concave heights whose particle size is about 1-10 micrometers may be formed, and the particle whose particle size is 1-10 micrometers may be made to adhere to the front face of the substrate for press at homogeneity about the formation approach of a surface layer of having heights or a crevice in the substrate for press.
[0041] Next, the surface layer of the substrate for press is pressed against a bump's 14 apical surface, and concave heights are formed in a bump's 14 apical surface.
[0042] As shown in drawing 3 (a), as shown in drawing 3 (b), concave heights are formed in a bump's 14 apical surface by forcing the deposit 21 with a particle size of 3-10 micrometers formed in the front face of a metal plate 20 to the bump 14 of the flexible substrate 12.
[0043] In the case of Au bump with a diameter of 40 micrometers, welding pressure at this time is per [5-50g] one bump, and if it is made, 15-25g are desirable [welding pressure]. Moreover, although the count of forcing can form the target concave heights mostly even once, it can fill uniformity more by pushing repeatedly 2 to 3 times. When pushing two or more times, it is good to shift the location of a metal plate 20, whenever it pushes once, and for a bump 14 to take care not to hit the same part of the deposit 21 formed in the front face of a metal plate 20.
[0044] Next, the surface protective coat which becomes a bump's 14 apical surface from a deposit is formed.
[0045] As a class of plating, any of electrolytic plating or electroless deposition are sufficient, and 1 micrometer or less is desirable so that the concave heights which Rh, nickel, Pd, W, etc. harder than nickel as a metallic material which constitutes a deposit were mentioned, and were formed in a bump's 14 apical surface as plating layer thickness may not hide.
[0046] Next, the manufacture approach of the probe card which consists of the hard substrate and bump who used silicon, glass, the ceramics, glass epoxy, etc. for the base material is explained.
[0047] Since the surface smoothness is not enough, a hard substrate is used after performing leveling (flattening). Usually, although the display flatness of a hard substrate changes with the base materials and processes, to the magnitude of a substrate, it is about 0.01 - 1%, and has the irregularity of several 10 micrometers or more with a 150mmx150mm substrate. Moreover, although the variation in bump height changes with the formation approaches, it is about 1-5 micrometers in 150mmx150mm area. Since a probe card cannot call it flatness to a semi-conductor wafer being very flat, the bumps of a probe card and no checking electrode of a semiconductor chip may not connect with coincidence certainly. Then, in order to connect both to coincidence certainly, leveling is performed to a probe card.
[0048] Hereafter, the approach of leveling is explained, referring to drawing 9 .
[0049] First, a metal electrode 44 is further formed through an interlayer insulation film 43 with the metal wiring 42 on a glass substrate 41. An epoxy resin, polyimide resin, etc. are used for an interlayer insulation film 43.
[0050] Next, a bump 45 is formed on a metal electrode 44 using a photosensitive resist etc. This bump's 45 tip is not located on the same flat surface, but produces several 100-micrometer variation from several 10 micrometers. As this key factor, there are variation of the display flatness of a glass substrate 41 and the thickness of an interlayer insulation film 43, variation of a bump's 45 height, etc.
[0051] The probe card which consists of a hard substrate and a bump is heated at about 180 degrees C in the condition of having inserted with the substrate of a flat pair. If it does in this way, the interlayer insulation film between lower layer metal wiring in a probe card and the upper metal electrode or between a base material and a metal electrode becomes soft, and the location at a bump's tip comes to be located on the same flat surface. Then, since the interlayer insulation film was deforming plastically even if it cooled the probe card to ordinary temperature, the location at a bump's tip has been located on the same flat surface.
[0052] The evaluation test hereafter performed in order to evaluate this invention is explained.
[0053] Drawing 4 shows how to push the bump 14 who has concave heights in an apical surface against the alumina layer 31 formed in the front face of the aluminum electrode 30. The forcing load in this case is about 10g per bump.

[0054] Drawing 5 shows the indentation formed in the alumina layer, when the bump of the shape of a conventional semi-sphere is pushed against an aluminum electrode, the hollow of the well-organized configuration is formed in the aluminum electrode, and the alumina layer is not fully torn.
[0055] Drawing 6 - drawing 7 show the indentation formed in the alumina layer, when the bump who manufactured according to said example is pushed against an aluminum electrode, the hollow of a complicated configuration is formed in the aluminum electrode also in which sample of No.1-No.6, and the alumina layer is torn certainly.
[0056] Drawing 8 measures the contact resistance at the time of pushing the bump (it being indicated as the concave convex bump all over drawing.) with a diameter of 40 micrometers who manufactured according to semi-sphere-like a conventional bump (it is indicated as the hemispherical bump all over drawing.) with a diameter of 40 micrometers and said conventional example against a checking electrode with a thickness of 1 micrometer it is thin from aluminum, respectively with the welding pressure of 10g per bump. In addition, a measurement current is 1mA. In the case of the bump of said example, compared with the case of the bump of the conventional example, contact resistance is decreasing greatly so that clearly from drawing 8 .

[Translation done.]

DESCRIPTION OF DRAWINGS

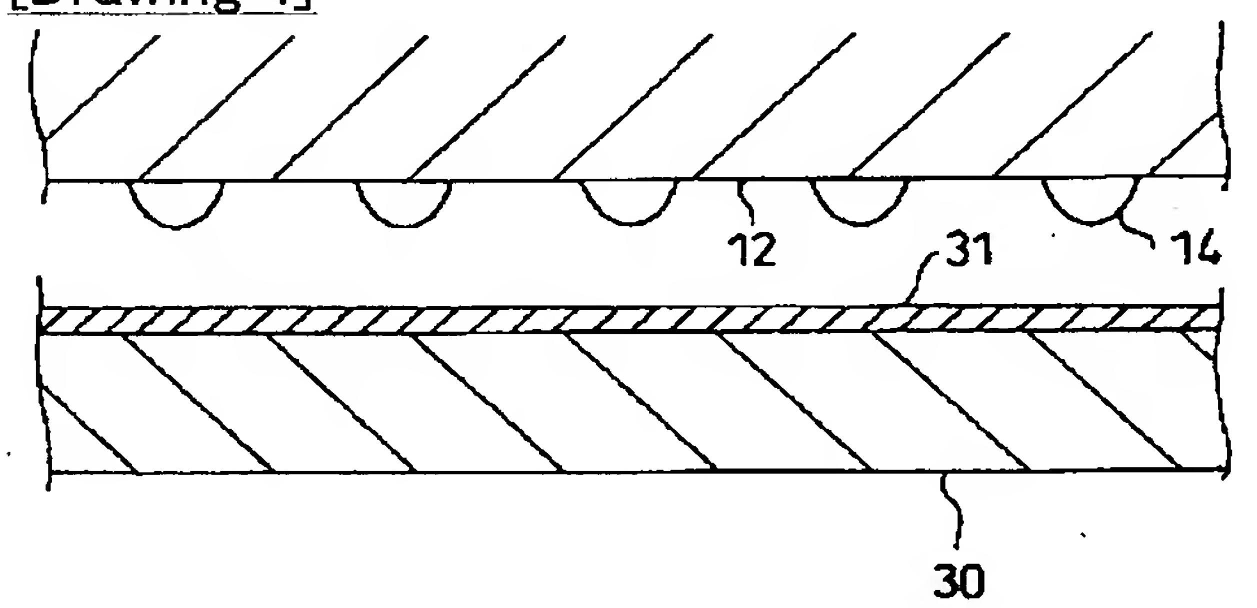
[Brief Description of the Drawings]
[Drawing 1] It is a sectional view explaining each process of the manufacture approach of the probe card concerning one example of this invention.
[Drawing 2] It is the photograph of the thin film which consists of a nickel particle formed on the surface of the metal plate in the manufacture approach of the probe card concerning said one example.
[Drawing 3] It is a sectional view explaining each process of the manufacture approach of the probe card concerning said one example.
[Drawing 4] It is the sectional view showing the approach of the evaluation test performed in order to evaluate this invention.
[Drawing 5] It is the photograph of the thin film in which the configuration of the indentation when pushing against an aluminum electrode the bump formed by the manufacture approach of the conventional probe card is shown.
[Drawing 6] They are the photograph of the thin film in which the configuration of the indentation when pushing against an aluminum electrode the photograph of the thin film a bump's front face formed by the manufacture approach of the probe card concerning said one example and said bump is shown, and its sketch.
[Drawing 7] They are the photograph of the thin film in which the configuration of the indentation when pushing against an aluminum electrode the photograph of the thin film a bump's front face formed by the manufacture approach of the probe card concerning said one example and said bump is shown, and its sketch.
[Drawing 8] It is drawing showing the relation of the bump's configuration and contact resistance which were formed by the manufacture approach of the probe card concerning one example of the former and this invention.
[Drawing 9] It is a sectional view explaining each process of the manufacture approach of the probe card concerning said one example.
[Description of Notations]
10 Copper Foil
11 Polyimide Layer
12 Flexible Substrate
13 Through Hole
14 Bump
20 Metal Plate
21 Deposit
30 Aluminum Electrode
31 Alumina Layer
41 Glass Substrate
42 Metal Wiring
43 Interlayer Insulation Film
44 Metal Electrode
45 Bump

46 Substrate

[Translation done.]

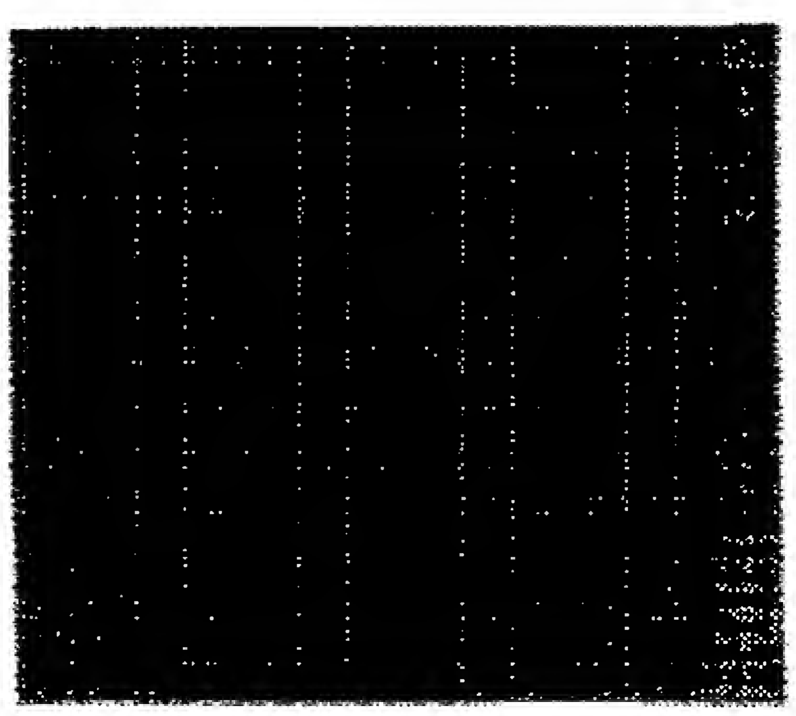
DRAWINGS

[Drawing 4]

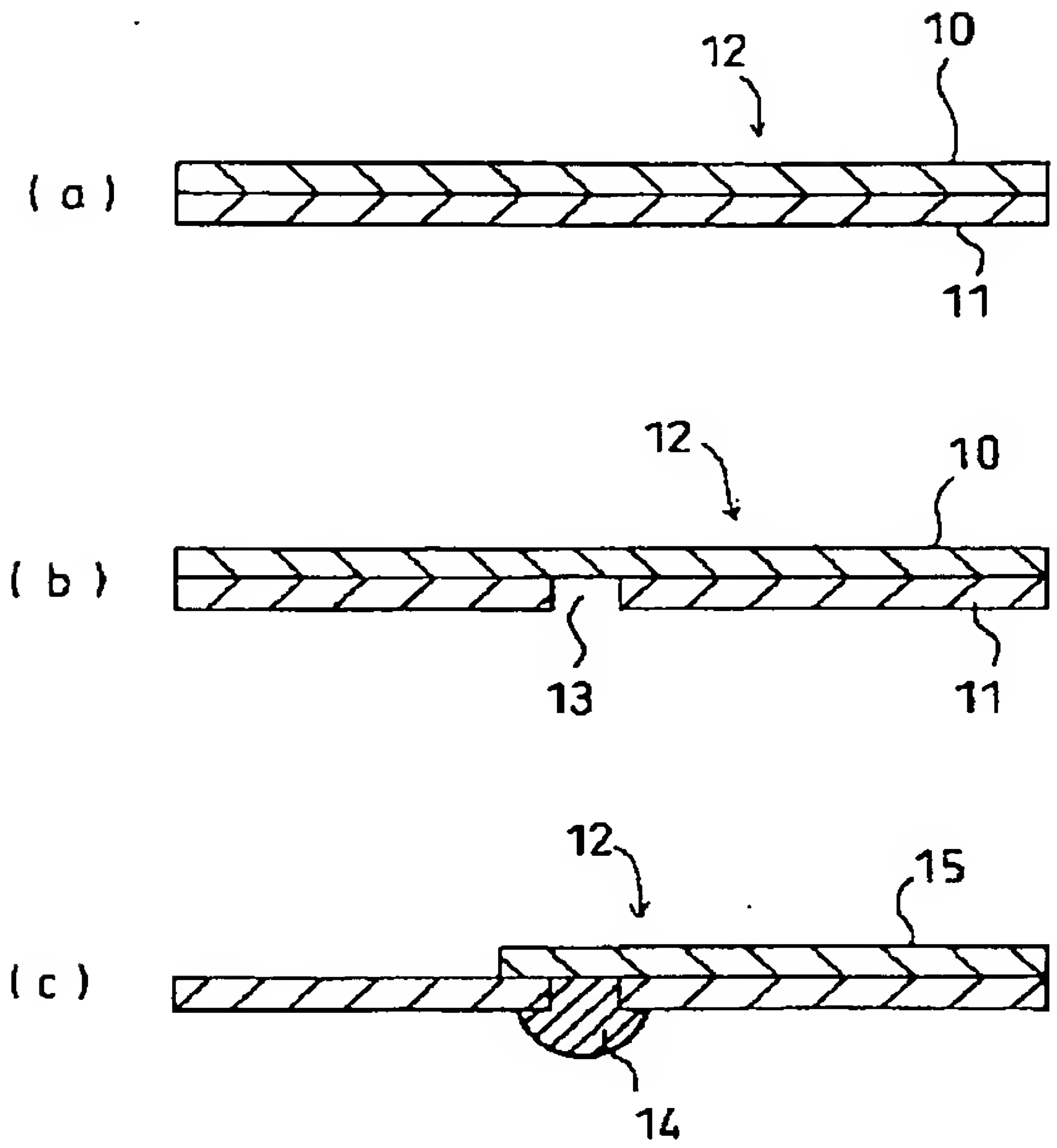


[Drawing 5]

図面代用写真

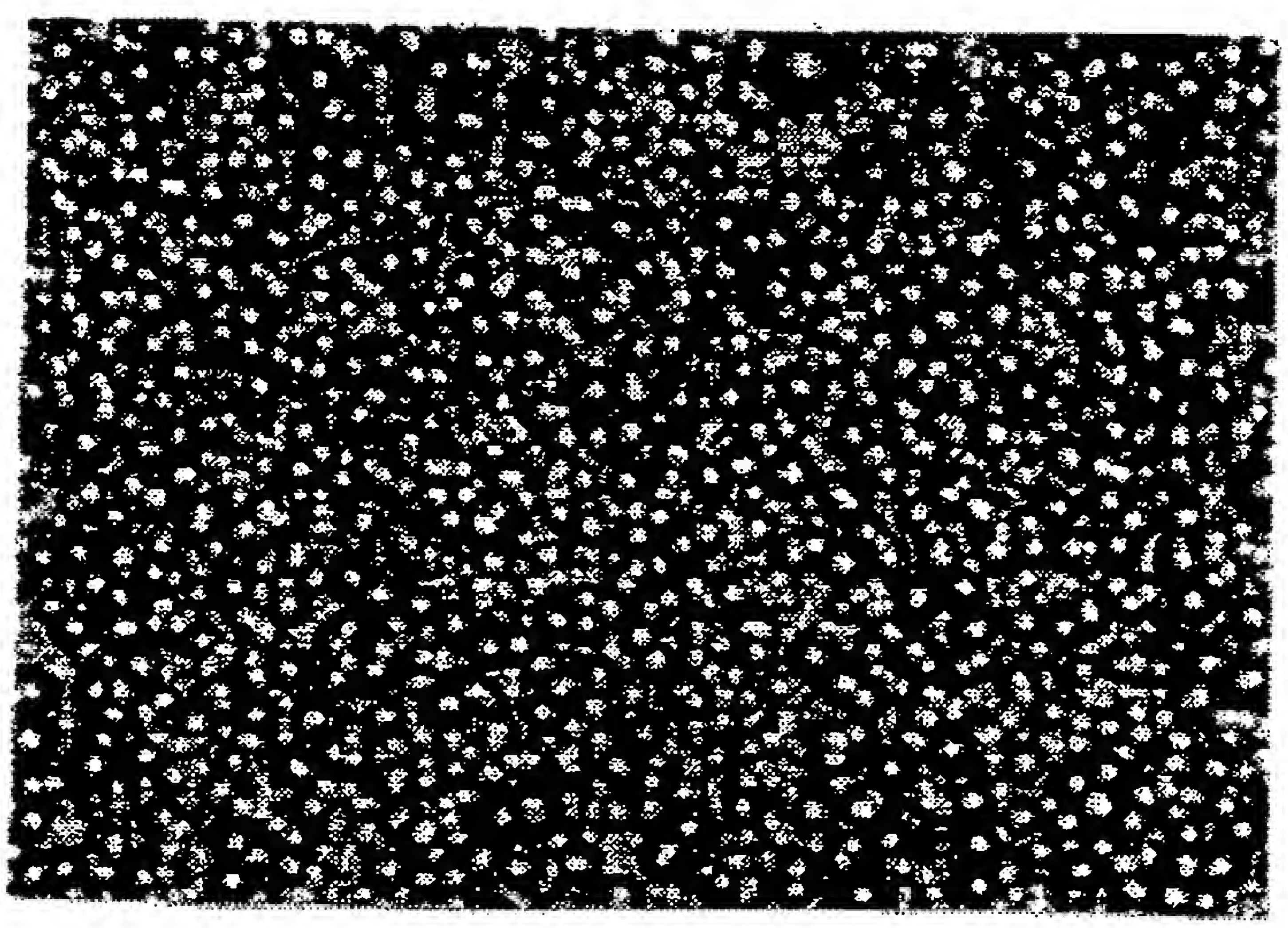


[Drawing 1]

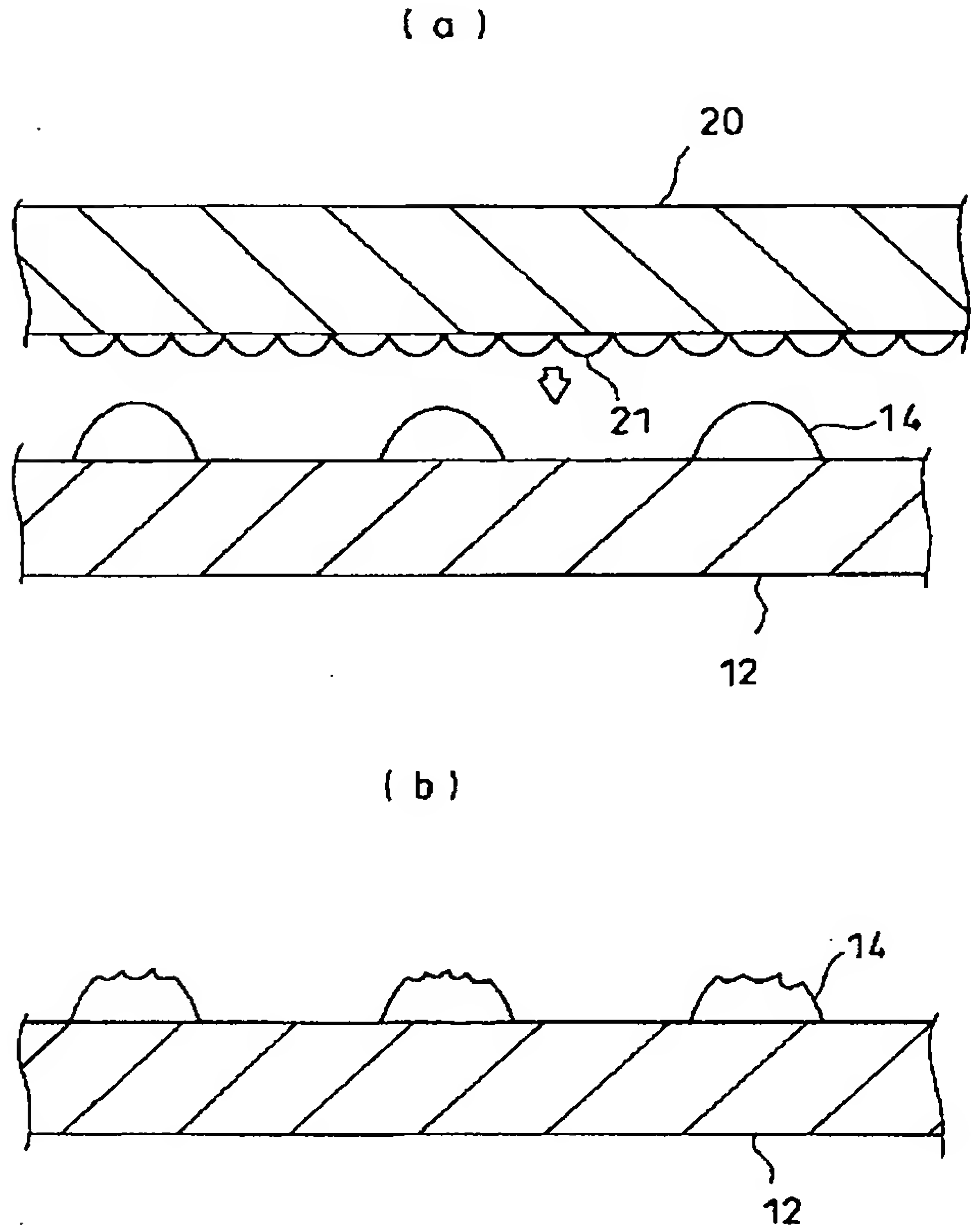


[Drawing 2]

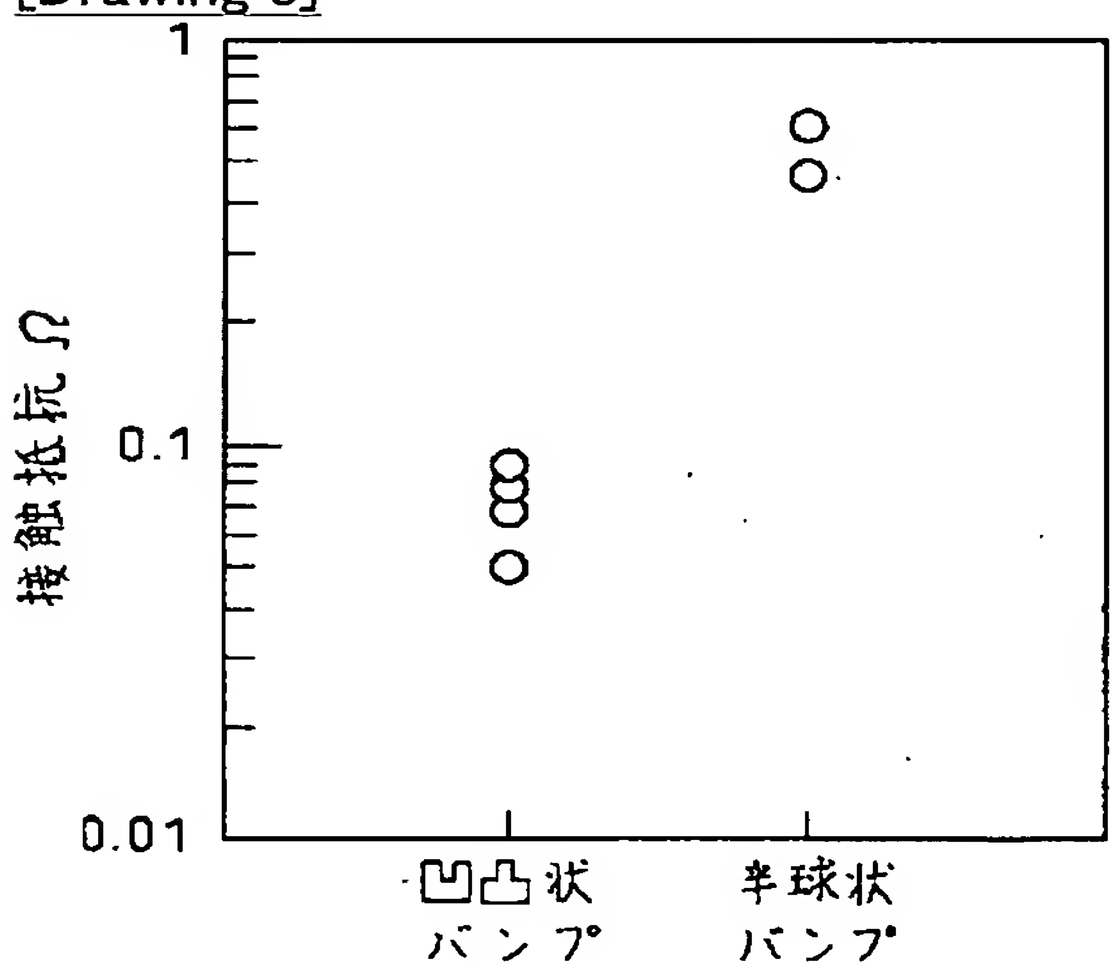
図面代用写真



[Drawing 3]

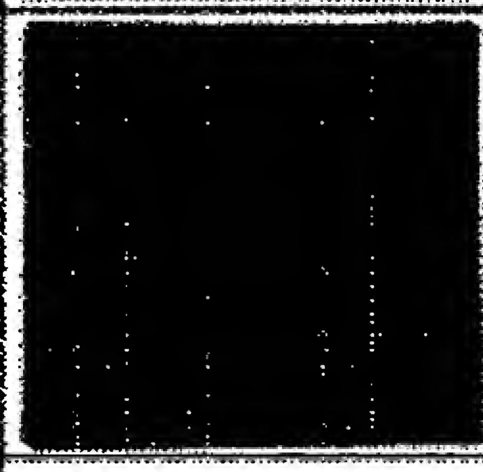
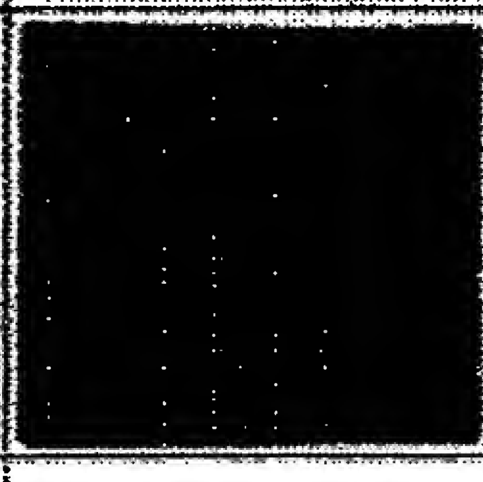
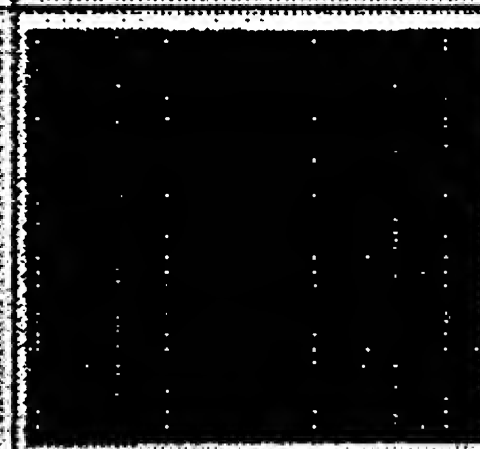
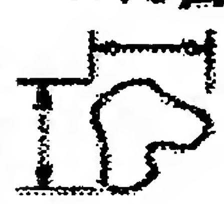


[Drawing 8]

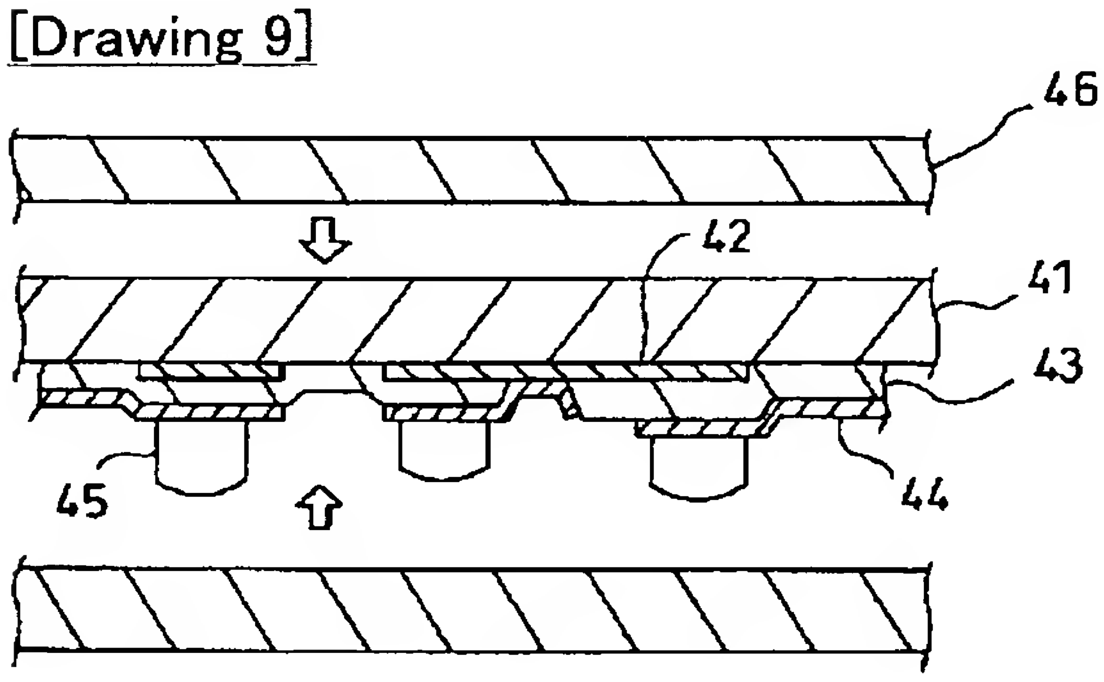


[Drawing 6]

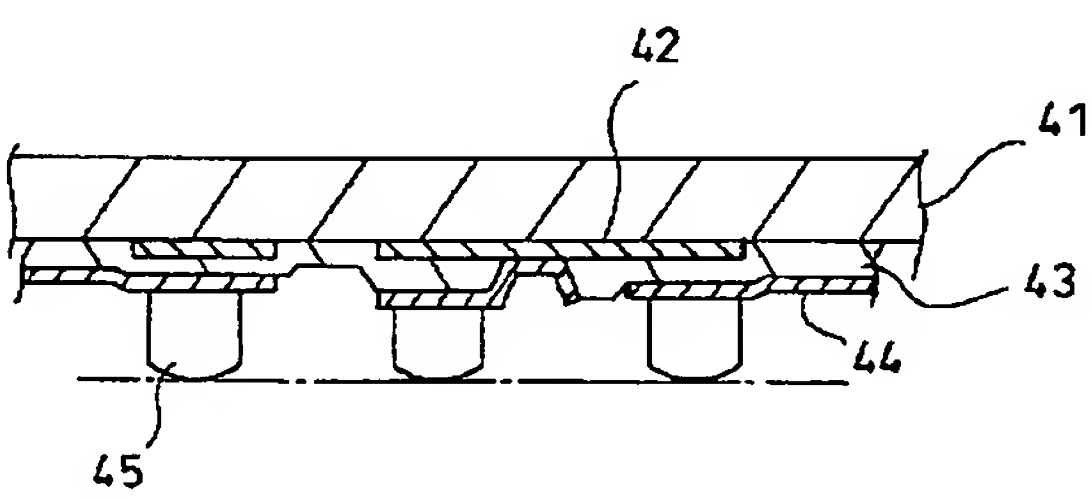
図面代用写真

	NO.1	NO.2	NO.3
凹凸を有するバンプ			
Al電極の圧痕の写真			
Al電極の圧痕のスケッチ	12.3μm 13.8μm 	14.0μm 12.7μm 	17.0μm 18.7μm 

[Drawing 9]



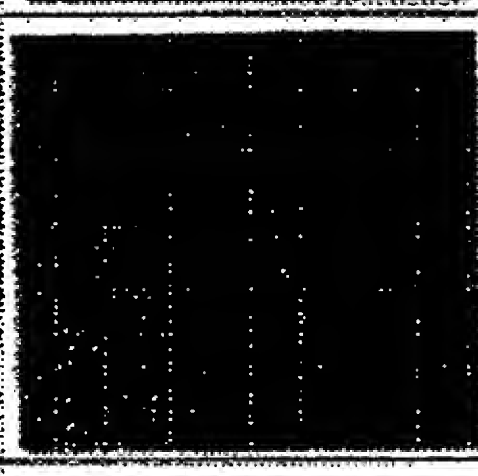
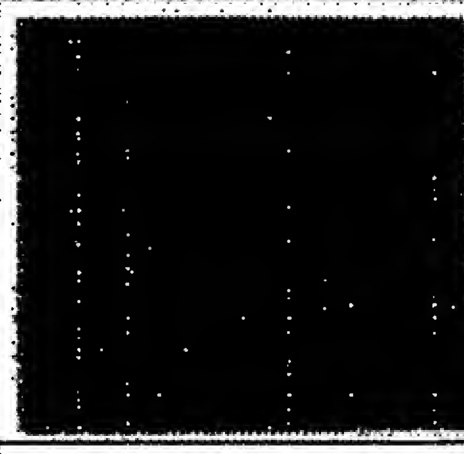
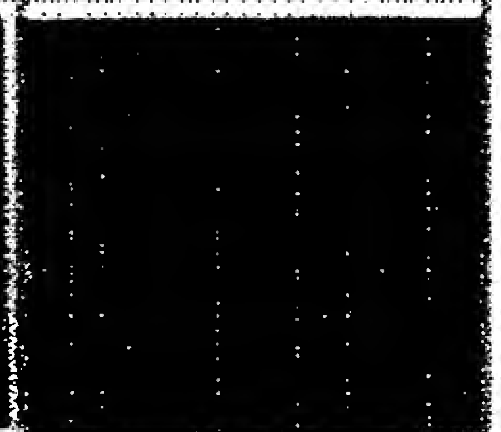
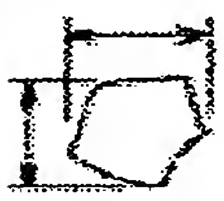
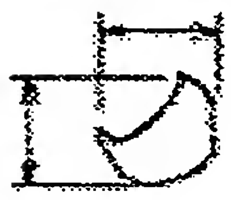
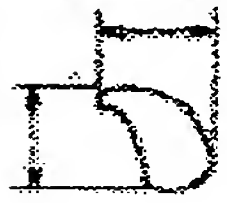
(a)



(b)

[Drawing 7]

図面代用写真

	NO.4	NO.5	NO.6
凹凸を有するバンプ			
Al電極の圧痕の写真			
Al電極の圧痕のスケッチ	15.8 μm 15.3 μm 	18.8 μm 18.9 μm 	14.7 μm 18.9 μm 

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